AL/OE-CR-1994-0009

ARMSTRONG LABORATORY

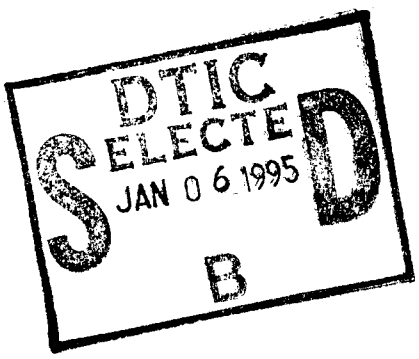
STORM WATER POLLUTION PREVENTION PLAN FOR CONSTRUCTION ACTIVITIES

Engineering-Science, Incorporated
57 Executive Park South, Suite 500
Atlanta, GA 30329

OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
2402 E. Drive
Brooks Air Force Base, TX 78235-5114

September 1994

Final Contractor Report



AIR FORCE MATERIEL COMMAND
BROOKS AIR FORCE BASE, TEXAS

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 1994	Final 1Mar 93-1 Mar 94

4. TITLE AND SUBTITLE
Storm Water Pollution Prevention Plan for Construction Activities

5. FUNDING NUMBERS
C – F33615-89-D-4003, Order 121

6. AUTHOR(S)
Engineering-Science, Incorporated

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Engineering-Science, Incorporated
57 Executive Park South, Suite 500
Atlanta, GA 30329

8. PERFORMING ORGANIZATION REPORT NUMBER
721002

9. SPONSORING/MONITORING AGENCY NAMES(S) AND ADDRESS(ES)
Armstrong Laboratory (AFMC)
Occupational and Environmental Health Directorate
2402 E. Drive
Brooks Air Force Base, TX 78235-5114

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
AL/OE-CR-1994-0009

11. SUPPLEMENTARY NOTES
Armstrong Laboratory Technical Monitor: Lieutenant Colonel John G. Garland III, (210) 536-3305

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

All construction sites as Robins AFB, Georgia with disturbed land area of five acres or greater are required to obtain a permit from the Georgia Environmental Protection Division to discharge storm water. Obtaining the storm water discharge permit is a two-step process:

- Submitting a Notice of Intent to discharge storm water; and
- Compliance with the State of Georgia's General Permit requirements.

A primary component of compliance with Georgia's General Permit requirements is the preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP). This document is organized to function as a guide to meet SWPPP requirements. The step-by-step guidelines and checklists show the process of developing and implementing a SWPPP for construction sites at Robins AFB, GA.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Storm water permitting Storm water pollution prevention plan	217
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

NOTICES

This technical report is published as received and has not been edited by the technical editing staff of the Armstrong Laboratory.

Publication of this report does not constitute approval or disapproval of the ideas or findings. It is published in the interest of STINFO exchange.

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely Government-related procurement, the United States Government incurs no responsibility or any obligation whatsoever. The fact that the Government may have formulated or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication, or otherwise in any manner construed, as licensing the holder, or any other person or corporation; or as conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

The mention of trade names or commercial products in this publication is for illustration purposes and does not constitute endorsement or recommendation for use by the United States Air Force.

The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

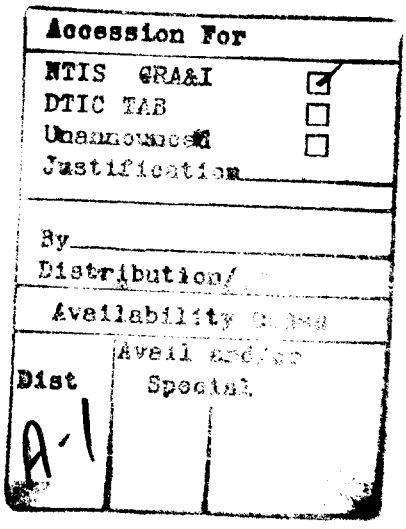
This report has been reviewed and is approved for publication.

Government agencies and their contractors registered with Defense Technical Information Center (DTIC) should direct requests for copies to DTIC, Building #5, Cameron Station, 5010 Duke St., Alexandria VA 22304-2103.

Non-Government agencies may purchase copies of this report from: National Technical Information Services (NTIS), 5285 Port Royal Road, Springfield VA 22161-2103.

JOHN G. GARLAND III, LtCol, USAF, BSC
Contract Project Officer

JAMES D. MONTGOMERY, LtCol,USAF, BSC,
Chief, Bioenvironmental Engineering
Division



NOTICE

Engineering-Science, Inc. has prepared this report for the United States Air Force for the purpose of aiding in the implementation of Air Force water regulations and Federal Clean Water Act regulations. It is not an endorsement of any product. The views expressed herein are those of Engineering-Science, Inc. and do not necessarily reflect the official views of the publishing agency, the United States Air Force or the Department of Defense.

NOTICE

The Georgia Environmental Protection Division has designated authority to regulate storm water discharges associated with construction activities in the State of Georgia. At the present time (December 1993), the court has nullified the Georgia General Permit authorizing storm water discharges associated with construction activities. This document has been prepared based on current Georgia regulations and guidance from the U. S. Environmental Protection Agency. When the Georgia General Permit is reissued, this document should be revised as appropriate to comply with the reissued General Permit.

STORM WATER POLLUTION PREVENTION PLAN FOR CONSTRUCTION ACTIVITIES

TABLE OF CONTENTS

Page

NOTICE i

SECTION 1: INTRODUCTION 1-1
1.1 Purpose 1-1
1.2 Organization 1-1
1.3 Storm Water Regulations 1-2
1.4 Definitions 1-2

SECTION 2: PREPARATION OF A SWPPP FOR CONSTRUCTION ACTIVITIES 2-1
2.1 Site Evaluation and Design Development 2-1
2.1.1 Collect Site Information 2-1
Existing Conditions Site Map 2-1
Soils Information 2-3
Runoff Water Quality 2-3
Name of Receiving Water 2-3
Rainfall Data 2-3
2.1.2 Develop Site Plan 2-4
2.1.3 Prepare Site Map 2-4
Approximate Slopes after Grading 2-5
Drainage Patterns 2-5
Areas of Soil Disturbance 2-5
2.2 Assessment 2-6
2.2.1 Measure Site Area 2-6
2.2.2 Measure the Drainage Areas 2-6
2.2.3 Calculate Runoff Coefficient 2-7
2.3 Control Selection/Plan Design 2-9
2.3.1 Select Erosion and Sediment Controls 2-9
2.3.2 Select Other Controls 2-9
2.3.3 Select Storm Water Management Controls 2-9
2.3.4 Indiate Location of Controls on the Site Map 2-10
2.3.5 Prepare Inspection and Maintenance Plan 2-11
2.3.6 Prepare Description of Controls 2-12
2.3.7 Coordinate Controls with Construction Activity 2-12
2.4 Certification/Notification 2-12
2.4.1 Soil Erosion and Sedimentation Control Permit 2-12
2.4.2 Storm Water Discharge Permit 2-13

STORM WATER POLLUTION PREVENTION PLAN FOR CONSTRUCTION ACTIVITIES

TABLE OF CONTENTS (Continued)

Page

2.4.3 Plan Location and Public Access 2-13
Plan Location 2-13
Public Access 2-13
2.4.4 Certification 2-13
2.5 Construction/Implementation 2-14
2.5.1 Implement Controls 2-14
2.5.2 Inspect and Maintain Controls 2-14
2.5.3 Maintain Records of Construction Activities 2-14
2.5.4 Changing the Plan 2-15
2.5.5 Releases of Reportable Quantities 2-15
2.6 Final Stabilization/Termination 2-16
2.6.1 Final Stabilization 2-16
2.6.2 Notice of Termination 2-16

SECTION 3: SEDIMENT AND EROSION CONTROL 3-1
3.1 Selection of Soil Erosion and Sediment Control Practices 3-1
3.1.1 Topography and Soils 3-1
3.1.2 Disturbed Soil and Exposure to Erosion Elements 3-2
3.1.3 Runoff From Offsite Areas 3-2
3.1.4 Runoff Across the Site 3-2
3.1.5 Retain or Accommodate Runoff 3-2
3.1.6 Sediment From Onsite Runoff 3-2
3.1.7 Stabilization 3-3
3.1.8 Watercourses 3-3
3.2 Sediment and Erosion Control Practices 3-3
3.2.1 Vegetative Practices 3-3
Temporary Vegetation 3-4
Permanent Vegetation 3-4
Mulching 3-4
Standards and Specifications 3-4
Buffer Zone 3-4
Disturbed Area Stabilization (With Mulching Only) 3-5
Disturbed Area Stabilization (With Temporary Seeding) 3-5
Disturbed Area Stabilization (With Permanent Vegetation) 3-5
Dust Control on Disturbed Areas 3-5

STORM WATER POLLUTION PREVENTION PLAN FOR CONSTRUCTION ACTIVITIES

TABLE OF CONTENTS (Continued)

Page

3.2.2 Structural Practices 3-5
Standards and Specifications 3-5
Checkdam 3-6
Channel Stabilization 3-6
Construction Exit 3-6
Diversion 3-6
Temporary Downdrain Structure 3-6
Permanent Downdrain Structure 3-6
Gabion 3-7
Grade Stabilization Structure 3-7
Level Spreader 3-7
Rock Filter Dam 3-7
Retaining Wall 3-7
Retrofitting 3-7
Sediment Barrier 3-7
Inlet Sediment Trap 3-8
Temporary Sediment Basin 3-8
Temporary Stream Crossing 3-8
Storm Drain Outlet Protection 3-8
Surface roughening 3-8
Topsoiling 3-9
Vegetated Waterway or Storm Water Conveyance Channel 3-9
3.3 Construction Techniques 3-9
3.4 Uniform Coding System 3-9

SECTION 4: OTHER CONTROLS 4-1
4.1 Waste Disposal 4-1
4.1.1 Construction Wastes 4-1
4.1.2 Hazardous Products 4-2
4.1.3 Contaminated Soils 4-3
4.1.4 Concrete Trucks 4-3
4.1.5 Sandblasting Grit 4-3
4.2 Minimizing Offsite Vehicle Tracking of Sediments 4-3
4.2.1 Construction Road Stabilization 4-3
4.2.2 Stabilized Construction Entrance 4-4
4.2.3 Maintenance and Repair Areas 4-4
4.3 Sanitary/Waste Disposal 4-5

STORM WATER POLLUTION PREVENTION PLAN FOR CONSTRUCTION ACTIVITIES

TABLE OF CONTENTS (Continued)

Page

4.4 Material Management 4-5
4.4.1 Pesticides 4-5
4.4.2 Petroleum Products 4-6
4.4.3 Fertilizers/Detergents 4-6
4.4.4 Hazardous Products 4-7
4.5 Spills 4-7
4.6 Control of Allowable Non-Storm Water Discharges 4-8
4.6.1 Dewatering 4-9
4.6.2 Sump Pit 4-10

SECTION 5: MAINTENANCE AND INSPECTION 5-1
5.1 Inspection 5-2
5.2 Maintenance 5-3
5.3 Recordkeeping 5-3
5.4 Training 5-3

SECTION 6: STORM WATER MANAGEMENT CONTROLS 6-1

APPENDIX A EXAMPLE OF A SWPPP FOR CONSTRUCTION ACTIVITIES AND AN EROSION AND SEDIMENT CONTROL PLAN

APPENDIX B STANDARDS AND SPECIFICATIONS FOR LAND DISTURBING ACTIVITIES

APPENDIX C FORMS

APPENDIX D SCS CHART METHOD FOR PEAK DISCHARGES

STORM WATER POLLUTION PREVENTION PLAN FOR CONSTRUCTION ACTIVITIES

LIST OF FIGURES

		Page
2.1	Developing and Implementing Storm Water Pollution Prevention Plan for Construction	2-2

LIST OF TABLES

		Page
2.1	Typical "C" Values for RAFB	2-8

SECTION 1
INTRODUCTION

1.1 PURPOSE

All construction sites at RAFB with disturbed land area of five acres or greater are required to obtain a permit from the Georgia Environmental Protection Division to discharge stormwater. Obtaining the stormwater discharge permit is a two step process:

- Submitting a Notice of Intent to discharge stormwater; and
- Compliance with the State of Georgia's General Permit requirements.

A primary component of compliance with Georgia's General Permit requirements is the preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP). The purpose of this document is to assist in the development and implementation of SWPPP's for construction sites at RAFB.

This document, authorized under Delivery Order 0121 of the Basic Contract F33615-89-D-4003, was prepared by Engineering-Science, Inc., Atlanta, Georgia for Armstrong Laboratory/OEB, Brooks AFB, Texas, and the Directorate of Environmental Management at RAFB, Warner Robins, Georgia.

1.2 ORGANIZATION

This document is organized to function as a guide to meet SWPPP requirements. The step-by-step guidelines and checklists show the process of developing a SWPPP. Section 2 provides an overview of the process of preparing a SWPPP for a construction site, and Sections 3-6 are resources for selecting sediment and erosion control practices to use as part of the SWPPP. The SWPPP shall be developed and implemented following the basic phases listed below:

- Site Evaluation and Design Development Phase;
- Assessment Phase;
- Control Selection/Plan Design Phase;
- Certification and Notification Phase;
- Implementation/Construction Phase; and
- Final Stabilization/Termination Phase.

1.3 STORM WATER REGULATIONS

Federal NPDES Program

In 1972, the Federal Clean Water Act was amended to provide that the discharge of pollutants to waters of the United States from any point source is effectively prohibited, unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. On November 16, 1990, US Environmental Protection Agency (EPA) published final regulations that established application requirements for storm water permits for specific categories of industries. Construction activities of five acres or more (or less than five acres if part of a common plan of development or sale) are defined in the regulations as an industrial activity. In Georgia, the EPA has delegated enforcement of this program to the Georgia Environmental Protection Division (EPD).

State Erosion and Sedimentation Act of 1975

On April 24, 1975, the Honorable George Busbee, Governor of the State of Georgia, signed into law Act 599, the Erosion and Sedimentation Act of 1975 (O.C.G.A. 12-7-1 et seq.).

As a result of Act 599, the State of Georgia developed the "Manual for Erosion and Sediment Control in Georgia" as a standard for all land disturbing activities.

This SWPPP incorporates the Federal and State storm water requirements for all construction projects at RAFB.

1.4 DEFINITIONS

Storm Water Pollution Prevention Plan (SWPPP). A plan that identifies potential sources of pollution which may reasonably be expected to affect the quality of storm water discharges from construction activities. The plan describes and ensures the implementation of practices which will be used to reduce the pollutants in storm water discharges associated with industrial activity at the construction site and ensures compliance with the terms and conditions of permits.

NPDES Storm Water Permit or permit. NPDES is an acronym for National Pollutant Discharge Elimination System. NPDES is the National program for issuing, modifying, revoking, etc., permits under Sections 307, 318, 402, and 405 of the Clean Water Act (CWA). A permit is an authorization issued by EPD to discharge under certain specified conditions.

Operator. The operator of a construction activity is RAFB, its designated representative, or authorized contractor.

SECTION 2
PREPARATION OF A SWPPP FOR CONSTRUCTION ACTIVITIES

The Storm Water Pollution Prevention Plan (SWPPP) is the key to controlling pollutants in storm water discharges for construction activities at RAFB. This section provides a step-by-step explanation of how to develop and implement the SWPPP for construction activities.

The process of developing and implementing a SWPPP for construction activities is divided into six phases which are indicated in Figure 2.1. These phases are:

1. Site Evaluation and Design Development,
2. Assessment,
3. Control Selection/Plan Design,
4. Certification/Notification,
5. Implementation/Construction, and
6. Final Stabilization/Termination.

The following sections describe the processes involved in each of the phases listed above. An example of a SWPPP is included in Appendix A.

2.1 SITE EVALUATION AND DESIGN DEVELOPMENT

The first phase in preparing a SWPPP for a construction project is to define the characteristics of the site and the type of construction which will be occurring. This phase is broken down into three tasks: collect site information, develop site plan, and prepare site map. The following subsections describe each of these tasks.

2.1.1 Collect Site Information

The first task in defining site characteristics is to collect information on the site which will be developed. The construction contract documents shall be used as the basis for information used in preparing the SWPPP.

Existing Conditions Site Map

Obtain a Base map of the existing conditions at the site. This map will be the starting point for the development of the site map required for the SWPPP. The Base

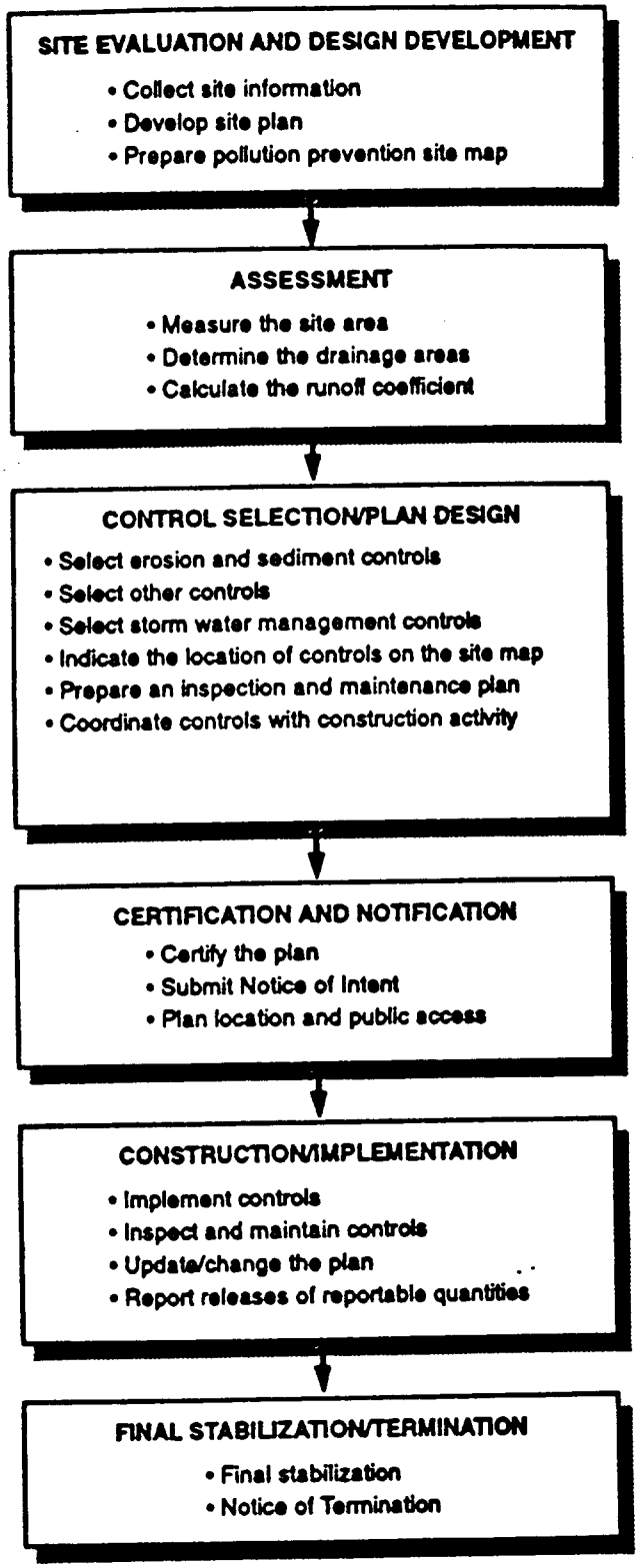


FIGURE 2.1 DEVELOPING AND IMPLEMENTING A STORM WATER POLLUTION PREVENTION PLAN FOR CONSTRUCTION

map is to scale and indicates existing topography. The Base map also indicates the existing land uses (i.e., wooded area, open grassed area, pavement, building, etc.) and the location of surface waters (i.e., wetlands, streams, rivers, lakes, ponds, etc.).

Soils Information

Determine the type of soils present on the site. This information shall be based upon information from the specific site and not regional characteristics. RAFB may have soil boring data on file for a particular site location. The Soil Conservation Service's (SCS) Soils Maps may also be used to determine types of soil on the site. The SCS Soil Surveys are excellent sources of information for surface soils and typically will indicate if a soil is erodible. Even more accurate information may be obtained by performing soil borings at the site.

Runoff Water Quality

Collect any information on the quality of the runoff from the site which may be available from RAFB Environmental Management Directorate. In many cases, there will be little water quality data from runoff collected specifically from a site; however, if the construction site is located near an existing industrial facility, or if it drains to a designated outfall location, water quality data may have been collected which indicates the quality of runoff from the site. Runoff water quality information may also be obtained from the U. S. Geological Survey (USGS), the USDA Soil Conservation Service (SCS), State or local watershed protection agencies.

Name of Receiving Water

Identify the name of the body of water which will receive runoff from the construction site. If the receiving water is a tributary, include the name of the ultimate body of water. Receiving waters include rivers, lakes, streams, creeks, runs, estuaries, wetlands, etc. If the site drains into a separate storm sewer system, identify the system and indicate the receiving water to which the system discharges. This information is available from the RAFB Base Maps.

Rainfall Data

Determine the amount of rainfall anticipated in the design of storm water management measures. These rainfall amounts are often referred to as "design storms." Design storms are typically described in terms of the average amount of time that passes before that amount of rain falls again and by the duration of the rain (e.g., the 10 year-24 hour storm). Contact the State/local storm water program agency for additional information on the design storm criteria in the project area.

2.1.2 Develop Site Plan

The next step in the process is to develop a preliminary site plan for the facility which is to be constructed. The site plan shall be developed based upon the goals and objectives of the proposed facility. However, there are several pollution prevention

principals which should be considered when developing the site plan for the project. These principles include:

- Disturb the smallest vegetated area possible;
- Keep the amount of cut and fill to a minimum; and
- Limit impacts to sensitive areas such as:
  - — Steep and/or unstable slopes;
  - — Surface waters, including wetlands;
  - — Areas with erodible soils; and
  - — Existing drainage channels.

Once the preliminary design is developed, a narrative description shall be prepared describing the nature of the construction activity. The narrative shall provide a brief description of the project including the purpose of the project (the final result); the major soil disturbing activities that will be necessary to complete the project; and the approximate length of time it will take to complete the project.

The purpose of construction (goal or project result) shall be described as one of the following: residential development, commercial development, industrial development, institutional development, office development, roads, parking lots, recreational areas, or underground utility.

When describing soil disturbing activities, include one or more of the following as applicable: clearing and grubbing, excavation and stockpiling, rough grading, final or finish grading, preparation for seeding or planting, excavation of trenches, demolition, etc.

The description of the construction activity shall not address indoor construction activities that will not affect the quality of storm water discharges.

2.1.3 Prepare Site Map

When the site plan is complete for the construction project, the information shall be transferred onto the pollution prevention plan site map. (Note: The construction site plan and the SWPPP site map can be the same map.) At this phase in the SWPPP development, there are three additional areas of detail which shall be indicated on the site map: the approximate slopes after grading, the site specific drainage pattern, and the areas of disturbance. [Note the surface waters should already be indicated on the map (see Section 2.1.1).]

Approximate Slopes After Grading

The revised grades shall be indicated on the same topographic map as the existing grades. Use two separate symbols for existing contours and proposed contours (i.e., dashed and solid lines). Indicate on the site map the approximate location, direction and

steepness of slopes. The location and direction of the slope shall be indicated by arrows (pointing from higher elevation to lower elevation) and numbers indicating the degree of slope.

Site Specific Drainage Patterns

The areas of soil disturbance shown on the SWPPP site map shall also indicate the drainage patterns of the site after the planned grading activities, including drainage basin boundaries and drainage channels or pipes. A drainage basin for the purposes of the SWPPP is an area of the site in which water, sediments and dissolved materials drain to a common outlet (such as a swale or storm drain pipe) from the site. There can be one or more drainage basins on a site. Drainage boundaries are closed lines which start and end at the common outlet. Drainage boundaries typically follow the high points on a site including hill tops, ridges, roads, etc. Drainage areas do not overlap. Areas that drain to different points are in different drainage areas. Drainage boundaries can be changed by grading and structural controls. The site map shall indicate the drainage boundaries after the planned grading has occurred or structural controls installed. It may be necessary to change the drainage boundaries after the structural controls are actually selected. Show the areas where there will be overland flow and the location of swales or channels. If there is a new or proposed underground storm drain system on the site, this shall be indicated on the SWPPP site map. The pipe diameter and slope shall also be included on the site map.

The SWPPP site map is not complete until the locations of the major control structures and the areas where stabilization is expected to occur are indicated. These items are discussed in Section 3.3.4.

Areas of Soil Disturbance

After indicating the proposed grading on the site map, the next step is to indicate the entire area which will be disturbed by the construction activity. This is indicated by drawing a "limit of disturbance" line on the site map. Draw the limit of disturbance so that any soil disturbing activity such as: clearing, stripping, excavation, backfill, stockpiling (topsoil or other fill material), and paving will be inside of the limit. The limit of disturbance shall also include roads for construction vehicles unless those roads are paved (or stabilized) and have measures to reduce tracking of sediments. The limit of disturbance shall be a closed boundary line around the entire disturbed area. There can be "islands" of undisturbed area inside the limit of disturbance, for example, a tree or group of trees which are to be preserved. These islands shall be encircled with a limit of disturbance.

2.2 ASSESSMENT

After the characteristics of the site and the construction have been defined, the next phase in developing a SWPPP is to measure the size of the land disturbance and estimate the impact the project will have on storm water discharges from the site. There are three tasks which shall be done to assess this impact. They include:

- measure site area;
- measure drainage areas; and
- calculate runoff coefficient.

2.2.1 Measure Site Area

The SWPPP shall indicate the total site area and the area which will be disturbed. This is determined from the SWPPP site map which shows the site boundary and the limit of disturbance. The area of the site can usually be found on the record plat, site survey, or the site plan. The amount of area to be disturbed is shown on a site plan, or grading plan.

The most accurate method to measure area from the site map is with a planimeter. A planimeter is a device which can measure the area on a drawing by tracing its outline. Planimeters are available from Engineering and Surveyor Supply Stores.

The first measurement is to determine the total area of the site. The total area of the site shall include the area inside the project's property boundaries, easements and/or right-of-ways. The total area includes both the disturbed and undisturbed areas. The second measurement is the area which will be disturbed by the construction project. This area can be determined by measuring the area enclosed by the limit of disturbance drawn in on the site map (see Section 2.1.2) and subtracting from this value the area of any undisturbed "islands" within the limit of disturbance. The disturbed area should always be less than or equal to the total site area.

2.2.2 Measure the Drainage Areas

The size of each drainage area where concentrated flow will leave the site shall be determined. Although this calculation is not included in the SWPPP, this information is needed to help select and design the sediment control and storm water management measures for the project.

For design of the sediment control measures, determine the portion of each drainage area which will be disturbed. The disturbed portion of the drainage areas shall be measured using the methods suggested above to estimate the area enclosed by the limit of disturbance and/or the drainage boundary (whichever boundary gives the smaller area).

For the design of the storm water management controls and for the calculation of the runoff volume, measure the total area of each drainage basin and the areas of each land use which will occur in the basin after the construction is complete. Be sure to include offsite water draining onto the site when determining the total size of the drainage basin. The area of each land use in the drainage areas shall be measured using the methods suggested above to estimate the area enclosed by the land use boundary and/or the drainage boundary (whichever boundary gives the smaller area).

2.2.3 Calculate the Runoff Coefficient

The next step in the assessment phase is to develop an estimate of the development's impact on runoff after construction is complete. This is done by calculating a runoff coefficient for post construction conditions. The runoff coefficient ("C" value) is the partial amount of the total rainfall which will become runoff.

There are several methodologies available to determine Q, the peak rate of runoff or discharge. The rational method is described in detail in this section. The Soils Conservation Service (SCS) Chart Method of determining peak discharges is found in Appendix D.

The runoff coefficient is used in the "rational method" runoff calculation:

$$Q = CIA,$$

where

Q = the peak rate of runoff in cubic feet per second
C = runoff coefficient
I = rainfall intensity in inches per hour, and
A = the area of the drainage basin in acres.

The less rainfall that infiltrates into the ground, evaporates, or is otherwise absorbed on site, the higher the "C" value. For example, the "C" value of a lawn area is 0.2, which means that only 20 percent of the rainfall landing on that area will run off; the rest will be absorbed or evaporate. A paved parking area has a "C" value of 0.9, which means that 90 percent of the rainfall landing on that area will become runoff. The "C" value calculated is the value that represents the final condition of the site after construction is complete. A runoff coefficient shall be calculated for each drainage area on the site.

The runoff coefficient for a variety of land uses is found in Table 2.1. These "C" values provide an accurate estimate of anticipated runoff for particular land uses. Most sites have more than one type of land use; therefore, more than one "C" value will apply. To determine a "C" value that represents the entire site a "weighted C" value shall be calculated.

This "weighted C" value takes into account the amount of runoff from all the various parts of the site. A formula used to determine the "weighted C" value is as follows:

$$C = \frac{A_1C_1 + A_2C_2 \ldots A_xC_x}{\sum A}$$

where A = the portion of the drainage area with a unique runoff coefficient, in acres and C = runoff coefficient for that portion of the drainage area

TABLE 2.1 TYPICAL "C" VALUES FOR RAFB

Description of Area	Runoff Coefficients
Residential	
Single-family areas	0.30-0.50
Multiunits, detached	0.40-0.60
Multiunits, attached	0.60-0.75
Industrial	
Light areas	0.50-0.80
Heavy areas	0.60-0.90
Parks, cemeteries	0.10-0.25
Playgrounds	0.20-0.35
Unimproved areas	0.10-0.30
Streets	
Asphalt	0.70-0.95
Concrete	0.80-0.95
Drives and walks	0.75-0.85
Roofs	0.75-0.95
Lawns - fine textured soil (greater than 40% clay)	
Slope: Flat, 2%	0.13-0.17
Average, 2-7%	0.18-0.22
Steep, 7%	0.25-0.35

2.3 CONTROL SELECTION/PLAN DESIGN

Once the site information has been collected and the impact the project will have on storm water discharge has been calculated, the next phase is to design a plan to prevent and control pollution of storm water discharge from the construction activity. In this phase, SWPPP shall address:

- erosion and sediment controls;
- storm water management controls; and
- other controls.

The following subsections detail how the controls selected shall be described in the SWPPP; however, the methods of selecting the appropriate measures and detailed information about the measures are contained in Sections 3-6.

2.3.1 Select Erosion and Sediment Controls

The first types of controls the SWPPP shall address are erosion and sediment controls. These controls include stabilization measures for disturbed areas and structural controls to divert runoff and remove sediment. Erosion and sediment controls are implemented during the construction period to prevent and/or control the loss of soil from the construction site into the receiving waters. Erosion and sediment controls can include temporary or permanent measures.

Selection of the most appropriate erosion and sediment controls for the construction project depends upon a number of factors, but is most dependent on site specific conditions. The information collected in the site evaluation and the design and assessment phase is used to select controls. Section 3 describes the more commonly used sediment and erosion control measures, and Appendix B provides typical design information for many of the measures described in Section 3. Appendix B is taken from Georgia's Manual for Erosion and Sediment Control.

2.3.2 Select Other Controls

In addition to erosion and sediment controls, the SWPPP shall address other potential pollutant sources which may exist on a construction site. They include: control of offsite vehicle tracking, compliance with RAFB waste disposal, sanitary sewer regulations, and control of allowable non-storm water discharges. Section 4 describes how to address each of these topics.

2.3.3 Select Storm Water Management Controls

The final controls which shall be addressed in the SWPPP are storm water management controls. Storm water management controls are constructed to prevent or control pollution of storm water after the construction is completed. These controls

include retention ponds, detention ponds, infiltration measures, vegetated swales, and natural depressions.

As with erosion and sediment controls, selection of the most appropriate storm water management measures is dependent upon a number of factors, but is most dependent on site specific conditions. The information collected in the site evaluation, design and assessment steps is used to select controls.

2.3.4 Indicate Location of Controls on the Site Map

Once the pollution prevention controls have been selected, they shall be indicated on the site map. Provide the location of each measure used for erosion and sediment control, storm water management and other controls. Below is a list which illustrates controls to be included on the site map.

Erosion and Sediment Control

Vegetative Measures
Buffer Zone
Disturbed Area Stabilization (with Mulching Only)
Disturbed Area Stabilization (with Temporary Seeding)
Disturbed Area Stabilization (with Permanent Vegetation)
Dust Control on Disturbed Areas

Structural Practices
Checkdam
Channel Stabilization
Construction Exit
Diversion
Temporary Downdrain Structure
Permanent Downdrain Structure
Gabion
Grade Stabilization Structure
Level Spreader
Rock Filter Dam
Retaining Wall
Retrofitting
Sediment Barrier
Inlet Sediment Trap
Temporary Sediment Basin
Temporary Stream Crossing
Storm Drain Outlet Protection
Surface Roughening
Topsoiling
Vegetated Waterway or Storm Water Conveyance Channel

Storm Water Management Controls

Storm water detention structures (including wet ponds)
Storm water retention structures
Natural depressions
Infiltration measures

The above list does not include every possible control measure. If the plan includes a measure not listed above, it should still be indicated on the site map.

Once the controls have been indicated on the site map, it may be necessary to revise the limit of disturbance and/or the drainage boundaries. The limit of disturbance shall be

indicated outside of any perimeter control, because the construction of most controls requires soil disturbance. Drainage boundaries are often impacted by diversion structures because the intent of a diversion device is typically to divert runoff from one drainage area to another. The drainage patterns on the site map shall reflect the drainage patterns on the site while the controls are in place.

Summarizing the above requirements, the SWPPP site map shall indicate:

- Location of project relative to roadways, major streams and other identifiable landmarks;
- Drainage patterns;
- Contours;
- Approximate slopes after grading;
- Area of soil disturbance;
- Soil type boundaries including boundary line, name, texture, slope, and depth;
- Location of major structural and nonstructural controls;
- Areas where stabilization practices are expected;
- Location of surface waters; and
- Other significant features including legend, map scales, north arrow, title blocks, seals and signatures.

2.3.5 Prepare Inspection and Maintenance Plan

Once the SWPPP is put into effect, an Inspection and Maintenance Plan must be developed to further prevent and control pollution of storm water on the construction site.

An inspection and maintenance checklist shall be prepared which addresses each of the control measures proposed for the facility. A blank checklist for the facility shall be included in the SWPPP prior to starting construction. The inspector shall complete a copy of the checklist during each inspection, and the completed checklist shall be inserted into an appendix of the SWPPP. The inspection and maintenance checklist shall be prepared based on the requirements for each individual control measure. For example, sediment must be removed from a silt trap when it has filled to one third of its depth.

As a minimum, inspection and maintenance requirements shall include:

- A description of procedures to maintain the following in effective operating condition:
  - — Vegetation;
  - — Erosion and sediment control measures; and

— Other protective measures identified in the site plan.

- Any inspection of disturbed areas of the construction site at least once every seven calendar days and within 24 hours of the end of a storm that is 0.5 inches or greater.

2.3.6 Prepare a Description of Controls

Once the construction activities are planned and the controls are selected, a list of each type of control to be used on the site shall be prepared. Include in this list a description of each control, its purpose and appropriateness in this location. The description shall also include specific information about the control measure such as size, materials, and methods of construction.

2.3.7 Coordinate Controls with Construction Activity

Prepare a list of the sequence of major activities and the tasks required for: construction of control measures, earth disturbing construction activities, and maintenance activities for control measures. Specific timing requirements for installation and maintenance of control measures are dependent upon the control measures and/or the construction activities. Refer to Sections 3, 4 and 5 for specific timing information on controls. The general principles listed below shall be followed:

- Install downslope and sideslope perimeter controls before the land disturbing activity occurs;
- Do not disturb an area until it is necessary for construction to proceed;
- Cover or stabilize a disturbed area as soon as possible;
- Time activities to limit impact from seasonal climate changes or weather events;
- Delay construction of infiltration measures to the end of the construction project when upstream drainage areas have been stabilized; and

6. Do not remove temporary perimeter controls until after all upstream areas are stabilized.

2.4 CERTIFICATION/NOTIFICATION

All construction sites at RAFB which disturb land area greater than 1.1 acres are required to meet specific requirements. Construction sites disturbing greater than 1.1 acres are regulated by Houston County Public Works. Construction sites that disturb five acres or greater are, in addition, regulated by the EPD.

2.4.1 Soil Erosion and Sedimentation Control Permit

All construction sites at RAFB with disturbed land area greater than 1.1 acres are required to have a Soil Erosion and Sedimentation Control Permit. A copy of the required permit application is included in Appendix C. The application shall be submitted to Houston County Public Works with a copy to RAFB Environmental Management Directorate for forwarding to the Soils Conservation Service for review.

The checklist used by the SCS to review Erosion and Sediment Control Plans can be found in Appendix C. A minimum of three copies of the Erosion and Sediment Control Plan shall be submitted with the permit application. Requirements for this plan are in Houston County Planning and Regulation of Development requirements Sec. 8-1145. An example of an Erosion and Sediment Control Plan is included in Appendix A.

2.4.2 Storm Water Discharge Permit

All construction projects at RAFB whose disturbed land area is 5 acres or greater require a permit to discharge storm water. To obtain the permit, the operator shall first obtain approval of the plan from RAFB EM and then submit a Notice of Intent (NOI) to the EPD. Appendix C includes a sample NOI form.

The NOI shall include:

- The mailing address of the construction site for which the notification is submitted; where a mailing address for the site is not available, the location of the approximate center of the site must be described in terms of the latitude and longitude to the nearest 15 seconds, or the section, township and range to the nearest quarter;
- The name of the receiving water(s), or if the discharge is through a separate storm sewer, the name of the operator of the storm sewer and the ultimate receiving water(s);
- The number of any NPDES permit for any discharge (including non-storm water discharges) for the site that is currently authorized by an NPDES permit.
- An indication of whether the site has existing quantitative data describing the concentration of pollutants in the storm water discharge (existing data should not be included as part of the NOI); and
- An estimate of project start date and completion date, estimates of the number of acres of the site on which soil will be disturbed, and a certification that a SWPPP has been prepared for the site in compliance with approved State and local sediment and erosion plans or permits and/or storm water management plans or permits. (A copy of the plans or permits should not be included with the NOI submission.)

2.4.3 Plan Location and Public Access

Plan Location

The SWPPP and supporting materials shall be kept by the operator (contractor) at the site of the construction operations at all times throughout the project.

Public Access

The SWPPP documents are considered to be "reports" according to Section 308(b) of the Clean Water Act, and therefore, are available to the public.

2.4.4 Certification

The site's SWPPP shall provide a list of all contractors and subcontractors who will implement the measures identified in the plan. In addition, these contractors and subcontractors shall sign a certification statement and provide their names, addresses and telephone numbers. These certifications shall be signed before the contractor begins activities and shall be filed with the site's SWPPP.

The following statement shall be signed in accordance with the signatory requirements described above.

"I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit that authorizes the storm water discharges associated with industrial activity from the construction site identified as part of this certification."

2.5 CONSTRUCTION/IMPLEMENTATION

Once the Notice of Intent has been filed and the SWPPP has been prepared and/or The Soil Erosion and Sediment Control Permit has been issued, construction may begin. The SWPPP shall be implemented at that time.

2.5.1 Implement Controls

Implement the controls specified in the SWPPP. The controls shall be constructed or applied in accordance with Appendix B. The controls shall be constructed and the stabilization measures applied in the order indicated in the previously discussed sequence of major activities.

2.5.2 Inspect and Maintain Controls

Inspection shall be performed at the frequency specified in the SWPPP. Any damage or deficiencies in the control measures shall be noted in an inspection report. The damage or deficiencies shall be corrected as soon as practicable after the inspection, and any changes that may be required to correct deficiencies in the SWPPP shall be made as soon as practicable after the inspection. Section 5 describes in further detail the inspection and maintenance activities which shall be performed.

2.5.3 Maintain Records of Construction Activities

In addition to the inspection and maintenance reports, records shall be kept of the construction activity on the site. Records shall include:

- Dates when major grading activities occur in a particular area;
- Dates when construction activities cease either temporarily or permanently; and
- Date when an area is stabilized.

2.5.4 Changing The Plan

If, at any time during the effective period of the permit, the EPD finds that the SWPPP does not meet permit requirements, the EPD will notify the operator of changes necessary to bring the plan into compliance.

Where there are changes in design, construction, operation, or maintenance of a site, and changes will have an effect on the potential for discharging pollutants in storm water at the site, the SWPPP shall be modified by the operator to reflect the changes and new conditions. For example, a change in the construction schedule or design specifications shall be incorporated in the SWPPP. The plan shall also be modified when it proves ineffective in controlling pollutants. This determination is made based on the results of regular visual inspections (see Section 5).

Any changes required by the EPD shall be made within 7 days of the notification. The operator shall submit a certification to the EPD that the requested changes have been made. The SWPPP shall also specify that the operator shall update the plan as necessary to reflect any changes onsite which may affect the potential for discharges of pollutants from the site.

2.5.5 Releases of Reportable Quantities

If the construction activity has a release of a hazardous substance or of oil in an amount which exceeds a reportable quantity (RQ) as defined in 40 CFR Part 110, 40 CFR Part 117, or 40 CFR Part 302, then the operator shall do the following:

- Call the National Response Center to report the spill (800-424-8802, or 202-426-2675) and RAFB EM (912-926-9777);
- Modify the site SWPPP within 14 days after the release to include:
  - A description of the release;
  - the date of the release;
  - an explanation of why the spill occurred;
  - a description of procedures to prevent future spills and/or releases ; and
  - a description of response procedures should a spill or release occur again.
- Submit a written description of the release within 14 days to include:
  - a description of the release, including the type of material and an estimated amount of spill;
  - the date of the release;
  - an explanation of why the spill occurred; and
  - a description of the steps taken to prevent and control future releases.

2.6 FINAL STABILIZATION/TERMINATION

2.6.1 Final Stabilization

As soon as practicable after construction activities have been completed in a disturbed area, permanent stabilization shall be started to prevent erosion of soil from that area. All disturbed areas of a site (except those portions which are covered by pavement or a structure) shall be stabilized once all construction activities are completed.

Final stabilization shall be considered complete when all soil disturbing activities at the site have been completed and a uniform perennial vegetative cover with a density of 70 percent has been established or equivalent permanent stabilization measures have been employed.

2.6.2 Notice of Termination

The Notice of Termination (NOT) is the final task required to comply with the requirements of an NPDES storm water permit for a construction activity. The NOT notifies EPD that the construction activity has ceased and the area is stabilized. The NOT applies to construction sites with disturbed land area of 5.0 acres or greater. Appendix C contains a copy of the NOT form.

The NOT shall include:

- mailing address of the construction site for which the notification is submitted; where a mailing address for the site is not available, the location of the approximate center of the site shall be described in terms of the latitude and longitude to the nearest 15 seconds, or the section, township and range to the nearest quarter;
- name, address and telephone number of the operator;
- NPDES permit number for the storm water discharge identified by the NOT; and
- following certification signed:

  "I certify under penalty of law that I am no longer the operator of the construction activity. I understand that by submitting this Notice of Termination, that I am no longer authorized to discharge storm water associated with industrial activity to waters of the United States. Discharge of storm water associated with industrial activity to waters of the United States is unlawful under the Clean Water Act where the discharge is not authorized by an NPDES permit. I also understand that the submittal of this Notice of Termination does not release an operator from liability for any violations of this permit or the Clean Water Act."

For the purposes of this certification, elimination of storm water discharges associated with industrial activity means that stabilization is complete for all disturbed areas at the identified facility, and temporary erosion and sediment control measures have

been removed or will be removed at an appropriate time. Finally, storm water discharges associated with construction activities from the identified site that are authorized by a NPDES permit have been eliminated.

SECTION 3
SEDIMENT AND EROSION CONTROL

This section describes soil erosion and sediment control practices and basic technical principles to provide for effective sediment control.

3.1 SELECTION OF SOIL EROSION AND SEDIMENT CONTROL PRACTICES

The soil erosion and sediment control portion of the SWPPP shall:

- Fit the activity to the topography and soils;
- Minimize the amount of disturbed soil and duration of exposure to erosion elements;
- Prevent runoff from offsite areas from flowing across disturbed areas;
- Retard the runoff flowing across the site;
- Retain or accommodate runoff;
- Remove sediment from onsite runoff before it leaves the site;
- Stabilize disturbed areas immediately; and
- Restrict encroachment upon watercourses.

The soil erosion and sediment control plan shall meet each of the objectives listed above. Methods of meeting these objectives depend on the nature of the construction activity and the characteristics of the site.

3.1.1 Topography and Soils

Detailed planning shall be employed to assure that roadways, buildings and other permanent features of the activity conform to the natural characteristics of the site. Large graded areas shall be located on the most level portion of the site. Areas subject to flooding shall be avoided. Areas of steep slopes and erodible soils with severe limitations for the intended uses shall not be used without overcoming the limitations through sound engineering practices. Erosion control development and maintenance costs can be minimized if a site is selected for a specific activity rather than attempting to modify the site to conform to the proposed activity.

3.1.2 Disturbed Soil and Exposure to Erosion Elements

Clearing of natural vegetation shall be limited to only those areas of the site to be developed at a given time. Natural vegetation shall be retained, protected and supplemented with construction scheduling employed to limit the duration of soil exposure. Major land clearing and grading operations shall be scheduled during seasons of low potential runoff.

3.1.3 Runoff From Offsite Areas

Divert offsite runoff around a disturbed area to reduce the amount of storm water which comes into contact with the exposed soils. If there is less runoff coming in contact with exposed soil, then there will be less erosion of the soil and less storm water which has to be treated to remove sediment.

3.1.4 Runoff Across the Site

Make grades as gradual as possible without modifying the existing site conditions significantly. Steeper slopes result in faster moving runoff, which results in greater erosion. (The USDA defines slopes of 2 to 9 percent as gently sloping; slopes of 9 to 15 percent are considered moderately steep; slopes of 30 to 50 percent are considered to be steep slopes; and slopes greater than 50 percent are considered very steep slopes.)

Steeply sloped areas can be protected by diverting the flow away from the face of the slope.

Vegetative cover increases the roughness of the runoff surface. The rougher surface slows the runoff.

3.1.5 Retain or Accommodate Runoff

Runoff from the construction site shall be safely conveyed to a stable outlet using storm drains, diversions, stable waterways or similar measures. Consideration shall also be given to the installation of storm water detention structures to prevent flooding and damage to downstream facilities resulting from increased runoff from the site. Temporary or permanent facilities for conveyance of storm water shall be designed to withstand the velocities of projected peak discharges. These facilities shall be operational as soon as possible after the start of construction.

3.1.6 Sediment From Onsite Runoff

Sediment basins, sediment barriers and related structures shall be installed to filter or trap sediment on the site to be disturbed. The most effective method of controlling sediment, however, is to control erosion at its source. Sediment retention structures shall be planned to retain sediment when erosion control methods are not practical, are insufficient, are in the process of being installed, or have failed due to some unforeseen factor.

3.1.7 Stabilization

Permanent structures, temporary or permanent vegetation and mulch, or a combination of these measures, shall be employed as quickly as possible after the land is disturbed but in no case more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased. Where construction activity will resume on a portion of the site within 21 days from when activities ceased, (i.e., the total time period that construction activity is temporarily ceased is less than 21 days) then stabilization measures do not have to be initiated on that portion of site by the 14th day after construction activity temporarily ceased. Temporary vegetation and mulches can be used on areas where it is not practical to establish permanent vegetation. These temporary measures shall be employed immediately after rough grading is completed if a delay is anticipated in obtaining finished grade. The finished slope of a cut or fill shall be stable and ease of maintenance considered in the design. Stabilize all roadways, parking areas, and paved areas with a gravel subbase, temporary vegetation or mulch.

3.1.8 Watercourses

Permanent buildings shall not be subjected to flooding, sediment damages or erosion hazards. Earth fills shall not be constructed in flood-prone areas so as to adversely obstruct water flows or increase downstream velocity of water flows. When necessary to span a flood-prone area or watercourse, bridge and culvert openings shall be sized to permit passage of peak discharges without causing undue restrictions in water flows or without creating excessive downstream velocities. Uses of flood-prone areas shall be limited to activities which would not suffer excessive damages from flooding, scour and sediment. Temporary bridges or culverts shall be employed when construction equipment is required to cross natural or constructed channels.

3.2 SEDIMENT AND EROSION CONTROL PRACTICES

The following sections describe sediment and erosion control measures that have been developed and standardized by the State of Georgia's 3rd Edition of the Manual for Erosion and Sediment Control and EPA. A combination of these measures shall be employed in a construction project at RAFB as part of the SWPPP. They fall into the two broad categories of vegetative and structural practices.

3.2.1 Vegetative Practices

Vegetative practices may be applied singularly or in combination with other conservation measures. They may be either short-lived or of a permanent nature. Choose materials that are compatible with the construction site soils, determined from results of soil testing during the Site Evaluation Phase and materials that are listed in RAFB "Natural Resources Management Plan." Steep gradients and long slopes will require special techniques and grasses which will resist erosion.

Temporary Vegetation

If grading of areas is completed at a time when it is not practical to establish permanent vegetation, these areas shall be stabilized by planting temporary annual grasses such as rye grass, rye, small grains and similar species. These temporary grasses will provide a rapid cover that can later be worked into the soil to provide organic matter when permanent vegetation is established. Select temporary plants that will be compatible with the final permanent vegetation.

Permanent Vegetation

A wide selection of various grasses, legumes, ground cover, trees and shrubs can be used for permanent vegetation. Vegetation already established at RAFB shall be used as a basis for selecting permanent vegetation at the construction site.

Ease of establishment, life expectancy, maintenance requirements, aesthetics and any other special qualities shall be considered in selecting permanent vegetation. Select plants requiring little maintenance. Many plants can be used to improve the aesthetics of a site and be effective soil stabilizers. Special attention shall be given to steep cut and fill slopes where plants requiring little maintenance must be utilized.

Mulching

It will often be impractical to stabilize an area with vegetation. Excellent soil stabilization can be achieved using wood chips, straw, hay, asphalt emulsion, jute matting and synthetic fibers. Areas where final grade has been reached can be stabilized with mulch and overseeded at the proper time for permanent grasses. Mulches allow for greater infiltration of water into the soil; reduce the amount of runoff; retain seeds, fertilizer and lime in place; and improve soil moisture and temperature conditions. Mulch is essential in establishing good stands of grasses and legumes on disturbed areas. In order to prevent movement by wind or water, it is important that it be anchored to the soil.

Standards and Specifications

The following is an overview of standards and specifications for vegetative practices further detailed in Appendix B which are suitable for use on disturbed land. A drawing legend code has been assigned to each practice and appears at the beginning of the title of each practice.

Bf -Buffer Zone

An undisturbed natural "green belt" surrounding the land-disturbing site or bordering streams. A buffer zone may reduce sediment and runoff, improve aesthetics, or reduce visual and noise pollution.

Ds1 - Disturbed Area Stabilization (With Mulching Only)

Using plant residues or other suitable materials on the soil surface to reduce runoff and erosion, conserve moisture, prevent soil compaction and crusting, control undesirable vegetation, modify soil temperature and to increase biological activity in the soil. This practice is applicable where stabilizing disturbed or denuded areas is not practical using seeding or plantings.

Ds2 - Disturbed Area Stabilization (With Temporary Seeding)

A temporary vegetative cover with fast growing seedings for disturbed or denuded areas. This practice is applicable for up to 12 months or until permanent vegetative cover can be installed. It should be coordinated with permanent measures to assure economical and effective stabilization.

Ds3 - Disturbed Area Stabilization (With Permanent Vegetation)

A permanent vegetative cover such as trees, shrubs, vines, grasses and legumes on disturbed or denuded areas. This specification is applicable on highly erodible or severely eroded areas where vegetation is difficult to establish by normal seeding or planting methods. It will apply on cut and fill slopes, earth spillways, borrow areas, spoil areas and severely eroded or gullied lands.

Du - Dust Control on Disturbed Areas

Controlling the surface and air movement of dust on construction sites, roadways and similar sites. Methods and materials which can be used include mulches, vegetative cover, spray-on adhesives, mechanical manipulation of existing soil surfaces, irrigation, barriers, chemicals, and stone surface covers.

3.2.2 Structural Practices

Where vegetative cover and mulches will not provide sufficient protection from the erosive forces of water, structural practices shall be used to curb erosion and sedimentation during land-disturbing activities. These practices shall be planned and employed in a practicable combination with vegetative and mulching measures.

Structural practices shall be adequately designed and properly installed to accomplish the desired objective. Design shall be based on the appropriate storm discharge and velocities. Consideration shall be given to the damage potential, safety hazards, planned life and required maintenance for each individual structural practice.

Standards and Specifications

The following is an overview of standards and specifications for structural practices contained in Appendix B.

Cd - Checkdam

A small temporary barrier or dam constructed across a swale or drainage ditch. This is applicable for use in small channels which drain five acres or less (not to be used in a live stream) in order to reduce erosion by slowing the velocity of concentrated storm water flows.

Ch - Channel Stabilization

Improving, constructing or stabilizing a natural or artificial channel for conveying water flows. In certain instances on selected developments, it will be found that existing channels will not be adequate to convey desired discharges. New channels may be required to eliminate flooding. In many cases existing channels cannot be considered stable. Therefore, this practice can be employed to assist in stabilizing these channels.

Co - Construction Exit

A stone-stabilized pad located at any point where vehicular traffic will be leaving a site onto a public right-of-way, street, roadway, or parking area. Its purpose is to reduce or eliminate transportation of soil (by motor vehicles) from the construction area onto Base roads.

Di - Diversion

An earth channel with a compacted supporting ridge on the lower side, constructed above, across, or below a slope. The purpose of this practice is to reduce slope lengths, break-up concentrations of runoff and move water to stable outlets at non-erosive velocities. Diversions may be either temporary or permanent and may be graded on either a level or sloping surface. Diversions should be designed to discharge water into established disposal areas.

Dn1 - Temporary Downdrain Structure

A flexible conduit of heavy-duty fabric or other material used as a temporary structure to convey concentrations of stormwater down the face of a cut or fill slope. Flexible downdrains are used on slopes where concentrations of storm water would cause erosion damages. They are removed once the permanent water disposal system is installed.

Dn2 - Permanent Downdrain Structure

A paved chute, pipe or a sectional conduit of prefabricated material designed to safely conduct surface runoff from the top to the bottom of a slope. Downdrain structures are to be used where concentrated water will cause excessive erosion of cut and fill slopes.

Ga - Gabion

Large, rock-filled baskets wired together to form flexible monolithic building blocks. They are used in channels, retaining walls, abutments, check dams, etc. to prevent erosion and sediment damage to a specific structure.

Gr - Grade Stabilization Structure

Structures of concrete, rock, masonry, steel, aluminum, treated wood, etc. They are installed to stabilize the grade in natural or artificial channels and to prevent the formation or advance of gullies and to reduce erosion and sediment pollution.

Lv - Level Spreader

A temporary structure constructed with a flat grade across a slope where concentrated runoff may be intercepted and diverted onto a stabilized outlet. Concentrated flow of stormwater is converted to sheet flow at the level spreader.

Rd - Rock Filter Dam

A permanent or temporary stone filter dam installed across small streams and drainageways. This structure is installed to serve as a sediment filtering device and to reduce storm water flow velocities.

Re - Retaining Wall

A constructed wall of concrete, masonry, reinforced concrete, cribbing, treated timbers, gabions, stone dry wall, riprap or other durable material. They are installed to stabilize cut or fill slopes where maximum permissible slopes of earth are not obtainable.

Rt - Retrofitting

The physical modification of a storm water management outlet structure, using a half round corrugated metal pipe or similar device, to trap sediment contained in runoff water.

Sd1 - Sediment Barrier

A temporary structure constructed of sand bags, straw or hay bales, brush, logs and poles, gravel or other filtering materials. They are installed to prevent sediment from leaving the site or from entering natural drainageways or storm drainage systems. They are not to be used on high risk areas or where there will be a possibility of failure. Designs are normally not required for sediment barriers.

Sd2 - Inlet Sediment Trap

Small temporary basins excavated around a storm drain inlet. They are employed to trap sediment in runoff water from small disturbed areas. Cleanout of these facilities is normally required after each heavy rainfall.

Sd3 - Temporary Sediment Basin

A basin created by an embankment or dam and containing a principal spillway pipe and an emergency spillway. These structures are normally situated within natural drainageways and at the lowest point on a construction site and are used to trap sediment contained in runoff water. Excavated basins may be employed where sites for embankments do not exist. Sediment basins serve only during the construction phase and are removed from the site when the disturbed area has been permanently stabilized.

Structure size will vary depending on the size of drainage areas, volume of sediments to be trapped, rainfall, structure location, etc. Adequate volume for sediment should be allocated for the anticipated life of the structure or provisions should be made for periodic cleanout. These structures can be regarded as being hazardous if constructed in areas of dense population. In these cases it is advisable to protect them from trespassing.

Permanent sediment basins are designed to fit into the overall plan of the completed development. They may be converted to storm water retention facilities to reduce storm water discharges.

This specification does not apply to the design of permanent sediment basins.

Sr - Temporary Stream Crossing

A temporary structure installed across a flowing stream or watercourse for use by construction equipment. The structure may consist of a pipe, bridge, or other suitable device permitting vehicular traffic without damaging stream banks and beds.

St - Storm Drain Outlet Protection

A paved or short section of riprap channel placed at the outlet of a storm drain system. The purpose is to reduce the velocity of water flows below storm drain outlets, and to prevent erosion from concentrated flow.

Su - Surface Roughening

Providing a rough soil surface with horizontal depressions created by operating a tillage or other suitable implement on the contour, or by leaving slopes in a roughened condition by not fine grading them. This aids in the establishment of vegetation, reduction of runoff, and reduction of sediment.

Tp - Topsoiling

Topsoiling areas to be vegetated by using a suitable quality soil. The purpose is to provide a suitable soil medium for vegetative growth on areas where desired stands of vegetation are difficult to establish and maintain.

Wt - Vegetated Waterway or Storm Water Conveyance Channel

Outlets for diversions, terraces, berms or other structures. They may be natural or constructed, shaped to required dimensions and paved or vegetated for disposal of storm water runoff. They may be of two general cross sections: parabolic or trapezoidal. Parabolic waterways are the most commonly used. For waterways to be successful it is essential that a protective cover of vegetation or other erosion protective measures be implemented. Flow velocities must be selected that will produce non-erosive flows within the waterway during peak discharges.

3.3 CONSTRUCTION TECHNIQUES

Other construction techniques available to implement the SWPPP are discussed below.

1. Leave Exposed Soil Surfaces Rough. Cut or fill slopes shall not be "dressed" or smoothed until time to establish vegetation. Cut or fill slopes may be scarified or serrated using conventional earth moving equipment to provide this roughening effect. The cleated tracks of bulldozers are effective in compacting as well as roughening cut or fill slopes.
2. Selective Fill Placement. Fills over culverts and conduits can be left in a condition to drain rain water to the upstream side of the culvert. This operation can be performed at the end of each construction day and will assist in retaining sediment on the site.
3. Selective Clearing. Clearing operations shall be confined to the removal of timber and heavy brush only. Ground covers consisting of small plants, weeds and organic matter should be retained until the start of the grading operation.
4. Retain Natural Sediment Traps. Small depressions in the land surface, natural creek berms and other natural sediment traps shall be preserved in a natural state until such time as building sequences will require their alteration.
5. Retention of Natural Vegetation. Natural vegetation on disturbed area perimeters and adjacent to stream channels shall be retained.

3.4 UNIFORM CODING SYSTEM

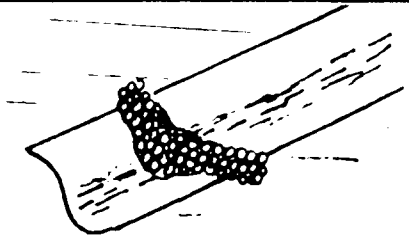
The following coding system shall be used to provide uniformity for erosion and sediment control plans. A code has been assigned to each practice. This code shall appear at the desired location on the plan. In some instances, more than one code will appear. For example, an area planted in temporary vegetation will eventually be established to permanent seeding. Therefore, both codes shall appear on the plans at the appropriate location. A symbol also has been assigned to most practices. For certain practices it will be necessary to place both the symbol and code letter on the plans.

UNIFORM

FOR SOIL EROSION AI

STATE SOIL AND WATER

STRUCTURAL PRACTI

CODE	PRACTICE	DETAIL	MAP SYMBOL	DESC
Cd	CHECKDAM			A small temporary across a swale, drai trated flow.

GEORGIA

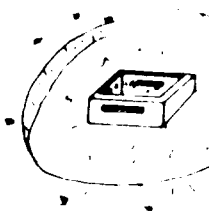
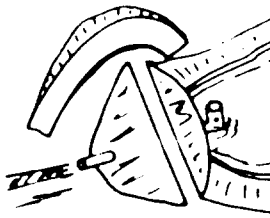
RM CODING SY

ON AND SEDIMENT CONTR

D WATER CONSERVATION COMMISSION C

RACTICES

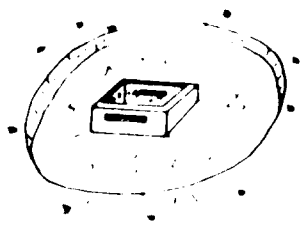
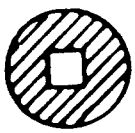
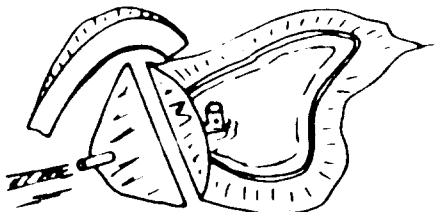
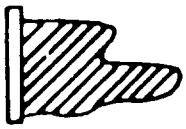
L	DESCRIPTION
	A small temporary barrier or dam constructed across a swale, drainage ditch or area of concentrated flow.

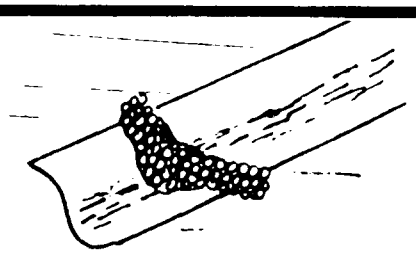
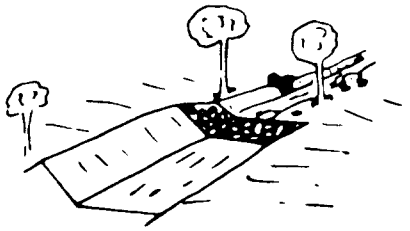
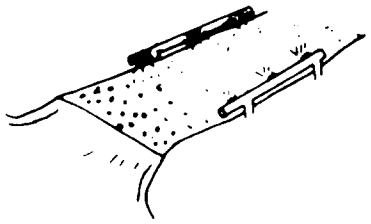
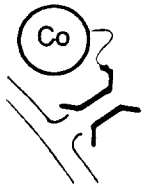
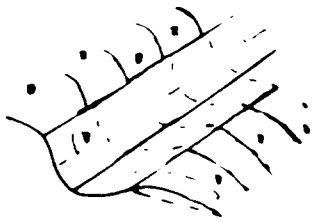
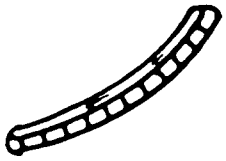
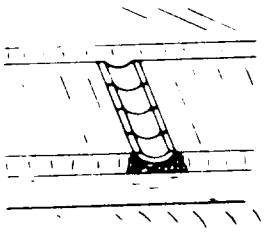
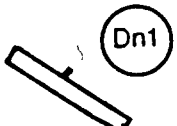
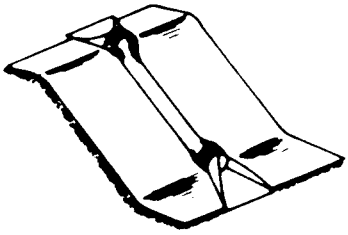
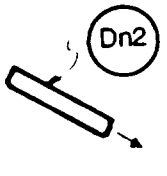
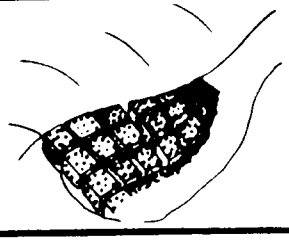
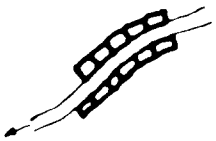
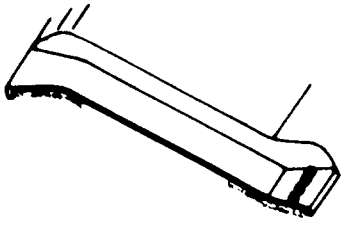
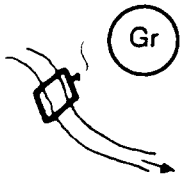
CODE	PRACTICE	DETAI
Sd2	INLET SEDIMENT TRAP	
Sd3	TEMPORARY SEDIMENT BASIN	

G SYSTEM

' CONTROL PRACTICES

MMISSION OF GEORGIA

CTICE	DETAIL	MAP SYMBOL	DESCRIPTION
NLET IENT TRAP			An impounding area created by excavating around a storm drain drop inlet. The excavated area will be filled and stabilized on completion of construction activities.
PORARY ENT BASIN			A basin created by excavation or a dam across a waterway. The surface water runoff is temporarily stored allowing the bulk of the sediment to drop out. The basin is usually temporary but may be designed as a permanent pond or stormwater retention device.

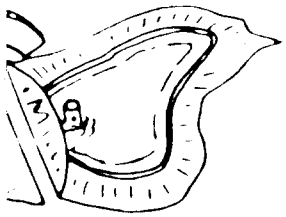
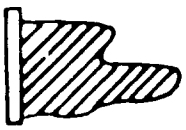
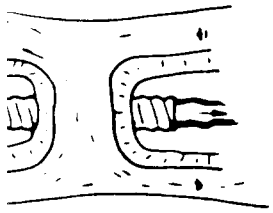
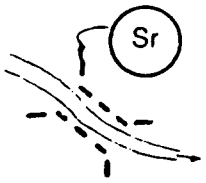
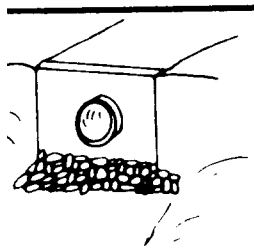
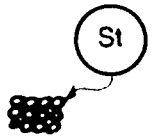
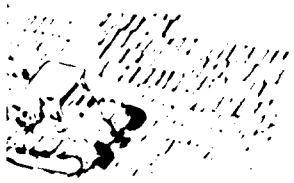
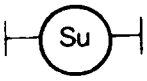
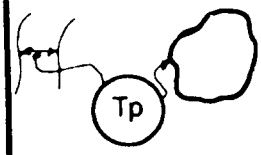
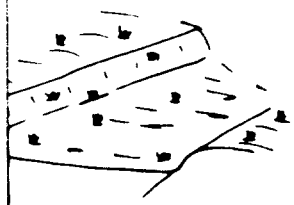
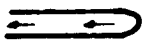
Cd	CHECKDAM			A small temporary b across a swale, drain trated flow.
Ch	CHANNEL STABILIZATION			Improving, constructi channel, existing stre
Co	CONSTRUCTION EXIT		 (Label)	A crushed stone pad site exit to provide a p tires thereby protectir
Di	DIVERSION			An earth channel or d across a slope to di temporary or perman
Dn1	TEMPORARY DOWNDRAIN STRUCTURE		 (Label)	A flexible conduit of material designed to s down a slope. This is t
Dn2	PERMANENT DOWNDRAIN STRUCTURE		 (Label)	A paved chute, pipe, material designed to s down a slope.
Ga	GABION			Rock filled baskets w position forming soil s
Gr	GRADE STABILIZATION STRUCTURE		 (Label)	Permanent structures artificial channels or v the slope would be su to form gullies.
				A structure to convert

Sd3	TEMPORARY SEDIMENT BASIN	A small temporary barrier or dam constructed across a swale, drainage ditch or area of concentrated flow.
Sr	TEMPORARY STREAM CROSSING	Improving, constructing or stabilizing an open channel, existing stream, or ditch.
St	STORM DRAIN OUTLET PROTECTION	A crushed stone pad located at the construction site exit to provide a place for removing mud from tires thereby protecting public streets.
Su	SURFACE ROUGHENING	An earth channel or dike located above, below, or across a slope to divert runoff. This may be a temporary or permanent structure.
Tp	TOPSOILING	A flexible conduit of heavy-duty fabric or other material designed to safely conduct surface runoff down a slope. This is temporary and inexpensive.
Wt	VEGETATED WATERWAY OR STORMWATER CONVEYANCE CHANNEL	A paved chute, pipe, sectional conduit or similar material designed tc safely conduct surface runoff down a slope.

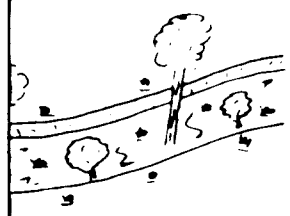
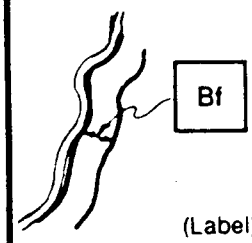
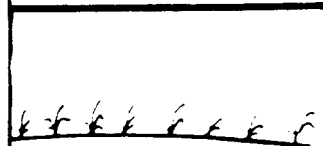
VEGETATIV

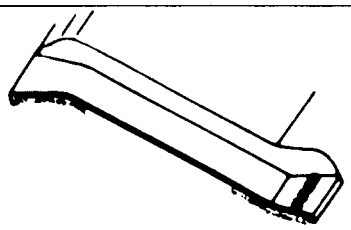
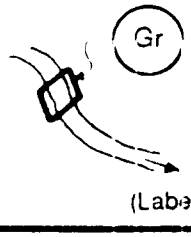
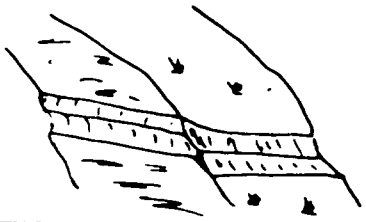
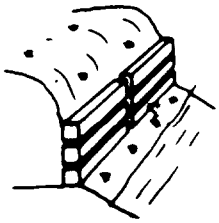
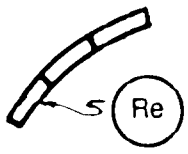
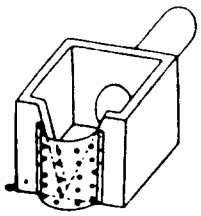
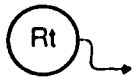
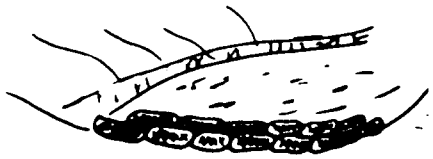
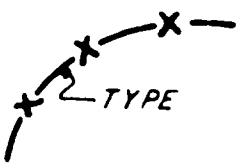
Bf	BUFFER ZONE	Rock filled baskets which are hand-placed into position forming soil stabilizing structures.
Cs	COASTAL DUNE STABILIZATION (WITH VEGETA-	Permanent structures installed to protect natural or artificial channels or waterways where otherwise the slope would be sufficient for the running water to form gullies.

A structure to convert concentrated flow of water

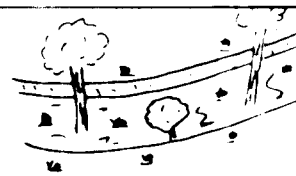
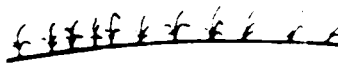
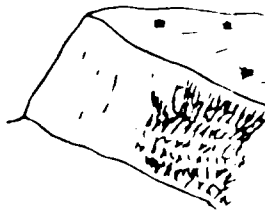
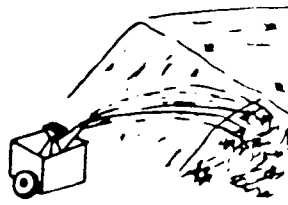
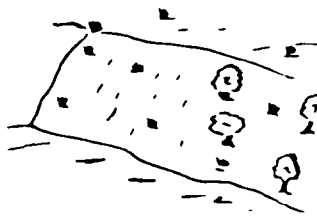
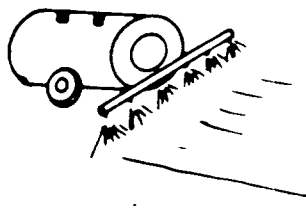
		A basin created by excavation or a dam across a waterway. The surface water runoff is temporarily stored allowing the bulk of the sediment to drop out. The basin is usually temporary but may be designed as a permanent pond or stormwater retention device.
	 (Label)	A temporary bridge or culvert-type structure protecting a stream or watercourse from damage by crossing construction equipment.
		A paved or short section of riprap channel at the outlet of a storm drain system preventing erosion from the concentrated runoff.
		A rough soil surface with horizontal depressions on a contour or slopes left in a roughened condition after grading.
	 (Show Striping & Storage Areas)	The practice of stripping off the more fertile top soil, storing it, then spreading it over the disturbed area after the completion of construction activities.
		Paved or vegetative water outlets for diversions, terraces, berms, dikes or similar structures.

ATIVE MEASURES

	 (Label)	An undisturbed natural "green belt" separating the land-disturbed site from surrounding property and bordering streams. It serves to reduce water velocity and remove some sediment. It is also at times a noise or "vision pollution" barrier.
		Planting vegetation on dunes that are denuded, artificially constructed, or re-nourished.

Gr	GRADE STABILIZATION STRUCTURE		 (Label)	Permanent structures artificial channels or the slope would be su to form gullies.
Lv	LEVEL SPREADER			A structure to conver into less erosive she structed only on undi
Rd	ROCK FILTER DAM			A permanent or tem stalled across small s
Re	RETAINING WALL		 (Label)	A wall installed to stab maximum permissibl Each situation will re
Rt	RETROFITTING		 (Label)	A device or structure p stormwater detention as a temporary sedin
Sd1	SEDIMENT BARRIER		 (Indicate type)	A barrier to prevent construction site. It r straw or hay, brush, sediment fence. The rary and inexpensive.

STATE SOIL AND WATE

Bf	BUFFER ZONE	
Cs	COASTAL DUNE STABILIZATION (WITH VEGETATION)	
Ds1	DISTURBED AREA STABILIZATION (WITH MULCHING ONLY)	
Ds2	DISTURBED AREA STABILIZATION (WITH TEMPORARY SEEDING)	
Ds3	DISTURBED AREA STABILIZATION (WITH PERMANENT VEGETATION)	
Du	DUST CONTROL ON DISTURBED AREAS	

Permanent structures installed to protect natural or artificial channels or waterways where otherwise the slope would be sufficient for the running water to form gullies.

A structure to convert concentrated flow of water into less erosive sheet flow. This should be constructed only on undisturbed soils.

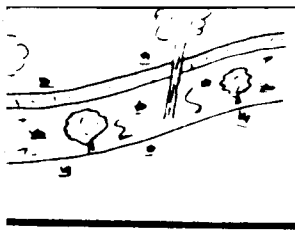
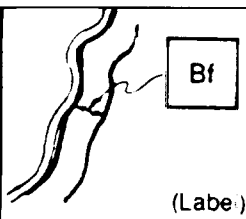
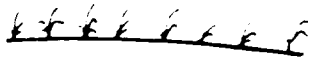
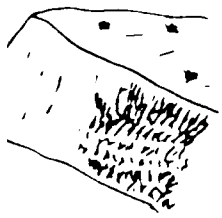
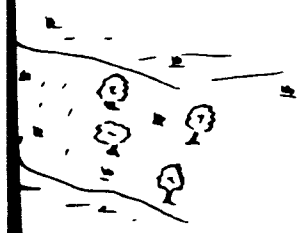
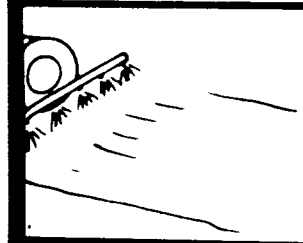
A permanent or temporary stone filter dam installed across small streams or drainageways.

A wall installed to stabilize cut and fill slopes where maximum permissible slopes are not obtainable. Each situation will require special design.

A device or structure placed in front of a permanent stormwater detention pond outlet structure to serve as a temporary sediment filter.

A barrier to prevent sediment from leaving the construction site. It may be sandbags, bales or straw or hay, brush, logs and poles, gravel, or a sediment fence. The barriers are usually temporary and inexpensive.

D WATER CONSERVATION COMMISSION O

	 Bf (Label)	An undisturbed natural "green belt" separating the land-disturbed site from surrounding property and bordering streams. It serves to reduce water velocity and remove some sediment. It is also at times a noise or "vision pollution" barrier.
	Cs	Planting vegetation on dunes that are denuded, artificially constructed, or re-nourished.
	Ds1	Establishing temporary protection for disturbed areas where seedings may not have a suitable growing season to produce an erosion retarding cover.
	Ds2	Establishing a temporary vegetative cover with fast growing seedings on disturbed areas.
	Ds3	Establishing permanent vegetative cover such as trees, shrubs, vines, grasses, sod, or legumes on disturbed areas.
	Du	Controlling surface and air movement of dust on construction sites, roadways and similar sites.

ON OF GEORGIA

SECTION 4
OTHER CONTROLS

This section covers the control measures and practices to be used to prevent contact between storm water and potential sources of contamination or pollution including chemicals, stored materials, building materials wastes, etc. This section also addresses controlling allowable non-storm water discharges on the site.

There are five areas of control (in addition to erosion and sedimentation controls for storm water management) that shall be addressed in each SWPPP. The five controls are: disposal of waste materials; minimization of offsite vehicle tracking of sediments; compliance with applicable sanitary sewer regulations; compliance with proper material management procedures, and appropriate pollution prevention measures for allowable non-storm water components of discharge. These controls are discussed in the following sections.

The following basic information shall be a part of the SWPPP:

- A narrative description of each practice;
- Location of each control measure on the site map;
- Description of the maintenance, inspection, repair, and recordkeeping procedures that will ensure control measures remain effective and in working order during the construction activity; and
- Description of employee training necessary for the operation and maintenance of the practice or control.

4.1 WASTE DISPOSAL

This section discusses the waste materials encountered at construction sites and discusses how these materials should be stored and handled so that their exposure to storm water is minimized.

4.1.1 Construction Wastes

Construction wastes include but are not limited to:

- Trees and shrubs removed during clearing and grubbing or other phases of construction;
- Packaging materials (including wood, paper, plastic, etc.);

- Scrap or surplus building materials, e.g., scrap metals, rubber, plastic and glass pieces, masonry products, and other solid waste materials;
- Paints and paint thinners; and
- Materials resulting from the demolition of structures (rubble).

The following steps will help ensure proper disposal of construction wastes:

- Select a designated waste collection area onsite;
- Provide an adequate number of containers with lids or covers that can be placed over the container prior to rainfall;
- Locate containers in a covered area when possible;
- Arrange for waste collection before containers overflow;
- Provide cleanup immediately following a container spill;
- Plan for additional containers and more frequent pickups during the demolition phase of construction;
- Collect, remove, and dispose of construction waste at authorized disposal areas; and
- Check with your local solid waste management agency for specific guidance.

4.1.2 Hazardous Products

Many of the materials found at a construction site may be hazardous to the environment or to personnel. A hazardous substance can be defined as any material that poses a threat to human health and/or the environment. Typical hazardous substances are toxic, corrosive, ignitable, explosive, or chemically reactive. These substances are designated pursuant to 40 CFR 302. A hazardous waste is defined as a waste or combination of wastes of a solid, liquid, contained gaseous, or semisolid form which may cause or contribute to adverse acute or chronic effects on the health of persons or other organisms. These wastes are designated pursuant to 40 CFR 261.3.

Read the labels of the materials or products onsite; they may contain warning information of a potential problem. At a minimum, consider any products in the categories listed below to be hazardous products (also see Section 4.4 for Material Management):

- Paints
- Acids for cleaning masonry surfaces
- Cleaning solvents
- Chemical additives used for soil stabilization (e.g., palliative such as calcium chloride); and
- Concrete curing compounds and additives.

Implement the practices listed below to avoid problems associated with the disposal of hazardous materials. Section 4.4 contains further information on storing and handling hazardous materials:

- Check with RAFB to determine what the requirements are for disposing of hazardous materials;
- Use all of the product before disposing of the container;
- Do not remove the original product label from the container;
- Do not mix products together unless specifically recommended by the manufacturer; and
- Follow the manufacturer's recommended method for disposal of the products.

4.1.3 Contaminated Soils

Contaminated soils may be encountered onsite during earth moving activities or during the cleanup of a spill or leak of a hazardous product. Material storage areas may also have been contaminated by undetected spills. The nature of the contaminants may or may not be known.

RAFB EM (912-926-9777) shall be contacted concerning information and procedures necessary to treat or dispose of contaminated soils. Some landfills may accept contaminated soil; however, laboratory tests may be required prior to a final decision.

4.1.4 Concrete Trucks

Concrete trucks shall not empty or wash out excess concrete on any construction site at RAFB.

4.1.5 Sandblasting Grit

A licensed waste management or transport and disposal firm shall be contacted to dispose of sandblasting grit.

4.2 MINIMIZING OFFSITE VEHICLE TRACKING OF SEDIMENTS

Control offsite tracking of sediments from traffic at the construction site by using the measures listed below:

- Construct a stabilized construction entrance and construction road;
- Clean paved streets adjacent to the site to remove any excess mud, dirt, or rock tracked from the site; and
- Schedule deliveries or other traffic at a time when personnel are available to provide cleanup if required.

4.2.1 Construction Road Stabilization

A stabilized construction road shall be well drained so that water does not puddle or flood the road during wet weather. The road will have a swale along one or both sides of the road to collect and carry away runoff. Stabilized construction roads shall have a layer of crushed stone or gravel to cover and protect the soil below from erosion.

A stabilized construction road shall be installed in a disturbed area where there will be a high volume of construction traffic expected. The construction road shall be stabilized at the beginning of construction and maintained throughout construction. Construction parking areas shall be stabilized as well as the roads. A stabilized construction road shall not be located in a cut or fill area until after grading has been performed.

Stabilized construction roads shall be built to conform to the site grades. They shall be designed such that the side slopes and road grades are not excessively steep. Construction roads shall not be constructed in areas which are wet, or on highly erodible soils.

4.2.2 Stabilized Construction Entrance

A stabilized construction entrance shall be constructed with filter fabric and stone and shall be installed before construction begins at every point where traffic leaves a disturbed area. Stabilized construction entrances shall be installed at the locations where the construction traffic enters an existing paved road; however, a stabilized construction entrance shall not be installed over existing pavement. Where the construction will require a permanent access road or driveway, a stabilized construction entrance shall be installed in this location prior to the permanent pavement.

Stabilized construction entrances shall be sized such that the largest construction vehicle will fit in the entrance. If a large amount of traffic is expected at an entrance, the stabilized construction entrance shall be wide enough to accommodate two vehicles across.

If the stabilized construction entrance has to cross a swale or stream, a stream crossing shall be provided.

Stone used for the construction entrance shall be large enough to prevent being tracked off site by the vehicle traffic. Sharp edged stone shall not be used.

If vehicles will be turning onto the paved road or drive from the stabilized construction entrance, an apron shall be provided so that vehicles do not leave the stabilized construction entrance before they leave the site.

The temporary construction entrance may be provided with a vehicle wash rack which drains to a temporary sediment trap or other sediment removing measure. This will allow vehicle tires to be washed prior to leaving the site and ensure that wash water sediments are removed and can be properly disposed.

4.2.3 Maintenance and Repair Areas

Designate a specific area within the construction site for equipment maintenance and repair.

4.3 SANITARY/WASTE DISPOSAL

Contact RAFB or its designated representative for Base regulations concerning sanitary waste disposal at construction sites.

4.4 MATERIAL MANAGEMENT

Storage and disposal methods of construction site materials shall comply with RAFB "Hazardous Waste Management Plan." The following are materials commonly found on a construction site. A material inventory list of materials stored onsite shall include these for risk assessment (if present):

- Pesticides;
- Petroleum products;
- Fertilizers and detergents (nutrients);
- Construction chemicals;
- Other pollutants; and
- Hazardous products (also see Hazardous Products Section 4.1.2).

The types of information to be considered when identifying risks include:

- What types of materials are stored onsite?
- How long will the materials be stored before use?
- Are materials stored in excess quantities?
- How are the materials stored and distributed?
- How can potential storm water contact be avoided?

4.4.1 Pesticides

The steps that should be taken to reduce the risks of using pesticides include the following:

- Handle the materials as infrequently as possible;
- Pesticide applicators shall be certified prior to application; and
- Observe all applicable Federal, State, and local regulations when using, handling, or disposing of these materials.

The management practices used to reduce the amounts of pesticides that could contact storm water include the following:

- Store pesticides in a dry covered area;
- Provide curbs or dikes to contain the pesticide if it should spill;
- Have measures onsite to contain and clean up spills of pesticies; and
- Strictly follow recommended application rates and recommended application methods, (i.e., only apply the amounts necessary for the job).

4.4.2 Petroleum Products

Oil, fuel line, lubricants, and asphaltic substances such as paving materials are considered petroleum products. These materials shall be handled carefully to minimize their exposure to storm water.

Petroleum products usually occur in the two site areas listed below:

- Areas where road construction is occurring; and
- Vehicle storage areas or areas of onsite fueling or equipment maintenance.

These following practices will help to reduce the risks in using petroleum products:

- Have equipment to contain and clean up petroleum spills in fuel storage areas;
- Have equipment to contain and clean up petroleum spills on board maintenance and fueling vehicles;
- Store petroleum products and fuel vehicles in covered areas where possible, and construct dikes to contain any spills;
- All temporary fuel storage shall be diked to contain spills;
- Contain and clean up petroleum spills immediately;
- Perform preventive maintenance for onsite equipment (e.g., check for and repair fuel or oil leaks in construction vehicles on a regular basis.); and
- Apply asphaltic substances according to manufacturers' instructions.

4.4.3 Fertilizers/Detergents

The steps that can be taken to reduce the risks of nutrient pollution include:

- Limit the application of fertilizers to the minimum area and the minimum recommended amounts;
- Reduce exposure of nutrients to storm water runoff by working the fertilizer deep into the soil (depth of 4 to 6 inches) instead of allowing it to remain on the surface;
- Apply fertilizer more frequently, but at lower application rates;
- Limit hydroseeding where lime and fertilizers are applied to the ground surface in one application;

- Limit the use of detergents onsite; washwater containing detergents should not be discharged in the storm water system;
- Implement erosion and sediment control to reduce the amount of fertilizers that leave the site; and
- Apply fertilizer and use detergents only in the recommended manner and only in recommended amounts.

4.4.4 Hazardous Products

As discussed in Section 4.1.2, hazardous materials include (but are not limited to) paints, acids for cleaning masonry surfaces, cleaning solvents, chemical additives used for soil stabilization, and concrete curing compounds.

Most problem situations involving hazardous materials and other pollutants are the result of carelessness. The practices listed below will help to avoid pollution of storm water by these materials.

- Have equipment to contain and clean up spills of hazardous materials in the areas where these materials are stored or used;
- Contain and clean up spills immediately after they occur; and
- Keep materials in a dry covered area.

4.5 SPILLS

Spill control and response methods shall comply with RAFB "Hazardous Waste Management Plan." A spill control plan shall be prepared which will include measures to:

- Stop the source of the spill;
- Contain the spill;
- Clean up the spill;
- Dispose of materials contaminated by the spill; and
- Identify and train personnel responsible for spill prevention and control.

The following measures shall be addressed in the spill prevention and response plan.

- Store and handle materials to prevent spills:
  - Tightly seal containers;
  - Clearly label all containers; and
  - Stack containers neatly and securely.
- Reduce storm water contact if there is a spill:
  - Clearly post cleanup procedures;

- Have cleanup materials readily available;
- Contain any liquid;
- Stop the source of the spill; and
- Cover spill with absorbent material.

- Dispose of contaminated materials according to manufacturer's instructions or according to RAFB "Hazardous Waste Management Plan."
- Identify personnel responsible for responding to a spill of toxic or hazardous materials:
  - Provide personnel spill response training; and
  - Post names of spill response personnel.
- Keep the spill area well ventilated;
- Use a private firm, if necessary, that specializes in spill cleanup.

4.6 CONTROL OF ALLOWABLE NON-STORM WATER DISCHARGES

NPDES storm water permits for construction activities include a prohibition against non-storm water discharges. All discharges covered by the permit shall be composed entirely of storm water. However, some non-storm water discharges, when combined with stormwater discharges, may be authorized by the permit. These exemptions may be allowed provided they are addressed in the SWPPP for the site. The following is a list of non-storm water discharges which are generally permitted.

- Discharges from fire fighting activities;
- Fire hydrant flushings;
- Potable water sources (including waterline flushings);
- Uncontaminated groundwater (including dewatering groundwater infiltration);
- Foundation or footing drains where flows are not contaminated with process materials such as solvents;
- Springs, riparian habitats, and wetlands;
- Irrigation water;
- Exterior building washdown which does not use detergents or other compounds;
- Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred and where detergents are not used; and
- Air conditioning condensate.

Common construction activity discharges that fall under the allowable non-storm water discharges include the following:

- Waterline flushings from the disinfection of newly installed potable water piping systems (provided chlorine levels meet regulatory requirements);
- Irrigation water discharged during seeding and planting practices;
- New construction exterior building washdown which does not use detergents or other compounds;
- Pavement wash waters from dust control and general housekeeping practices;
- Foundation and footing drain discharges from subsurface drainage systems; and
- Uncontaminated groundwater from dewatering of excavated areas.

There are three choices for handling non-storm water discharges which are not permitted:

- Eliminate the source of the discharge;
- Apply for a separate permit for the discharge; or
- Direct the discharge to a sanitary or industrial sewer system. (Note: Check with RAFB EM (912-926-9777) to see if discharge of the material in question into the sanitary or industrial sewer is allowed).

The allowable non-storm water discharges should be identified in the SWPPP. For each of the discharges, practices or controls that will be used to prevent pollution from these discharges shall be described in detail.

The following general practices shall be considered:

- Downslope site sedimentation and erosion controls shall be in place prior to the discharge;
- Discharges with sediment loads shall be discharged so that sediment pollution is minimized; these discharges include dewatering operation discharges and discharges from sediment traps and basins.
- Discharges shall be directed only to areas that are stabilized to minimize erosion (e.g., buffer zones, vegetated filter strips, inlet and outlet protection, level spreaders, etc.); discharges of non-storm water shall not flow onto disturbed areas.

Discharges with sediment shall be directed to pass through a sediment filtering device. Sediment filtering devices include sediment traps, basins, silt fences, vegetated filter strips, sump pits, or sediment tanks.

4.6.1 Dewatering

Dewatering shall be used during construction to remove accumulated water and sediments from sediment traps and basins to ensure their effectiveness throughout the entire project. At the end of the project, dewatering of sediment traps and basins is appropriate prior to removing the last sediment control measures. Water remaining in

excavated areas shall be eliminated by dewatering so that construction can proceed on schedule.

Dewatering discharges usually have a very high sediment content; therefore, sediment control should be provided before the discharge enters a receiving water. Sediment traps and basins shall be used to remove sediment from dewatering of excavation areas.

Filtering shall also be provided when discharge results from dewatering a sediment trap or basin. Methods to consider for this purpose are noted below in order of preference:

- A sump pit - discussed in detail in Section 4.6.2;
- A floating suction hose which allows clean water at the surface to be pumped out before the hose sinks low enough to pick up sediment-laden water; and
- A standpipe attached to the base of the sediment basin riser with slits to control inflow and wrapped with filter fabric to filter sediments.

4.6.2 Sump Pit

A sump pit may be used to dewater a sediment trap or basin, or it may be used during construction when water collects in an excavation. The number of sump pits and their location will depend on the individual site and any State or local requirements. The standpipe shall have holes to allow water to flow in and shall be extended at least a foot over the top of the pit. If the sump pit is to discharge directly into a receiving water, the standpipe shall be wrapped in filter fabric before the pit is backfilled with stone.

SECTION 5
MAINTENANCE AND INSPECTION

This section discusses the general maintenance and inspection for proper implementation of the SWPPP.

Inspect and maintain the disturbed areas of the site, areas of material storage, and the erosion and sediment controls identified in the SWPPP. These measures may include (but are not limited to) any of the following:

- Seeded areas (permanent or temporary);
- Mulched areas;
- Areas stabilized with geotextiles;
- Sod stabilized areas;
- Silt fences;
- Earth dikes;
- Brush barriers;
- Drainage swales;
- Sediment traps;
- Subsurface drains;
- Pipe slope drains;
- Level spreaders;
- Storm drain inlet protection measures;
- Rock outlet protection;
- Reinforced soil retaining systems;
- Gabions; and
- Sediment basins.

Inspect and maintain the pollution prevention measures on the construction site as long as a portion of the site remains disturbed.

Appendix A includes a sample maintenance and inspection plan. The maintenance and inspection plan shall accomplish the following:

- Identify all of the areas/measures that will be inspected and maintained;

- Provide an inspection schedule for each area/measure;
- List the typical maintenance procedures for each measure;
- Describe the procedure to follow if additional repair is required, e.g., who will be responsible or whom to call;
- Provide forms and instructions for record keeping practices;
- List the names of personnel assigned to each task; and
- Indicate what training employees will need to be able to do the job.

5.1 INSPECTION

Inspections shall be made by the operator at a minimum of once every seven calendar days and within 24 hours after any storm event of greater than 0.5 inches. Areas of the site that shall be observed during such inspections include disturbed areas, areas used for storage of materials that are exposed to precipitation, structural control measures, and locations where vehicles enter or exit the site.

Disturbed areas and areas used for storage of materials that are exposed to precipitation shall be inspected for evidence of, or the potential for, pollutants entering the runoff from the site. Erosion and sediment control measures identified in the SWPPP must be observed to ensure that they are operating correctly. Appendix B identifies minimum requirements for measures used. Observations can be made during wet or dry weather conditions. Where discharge locations or points are accessible, they must be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. This can be done by inspecting the receiving water to see whether any signs of erosion or sediment are associated with the discharge location. Locations where vehicles exit the site shall be inspected for evidence of offsite sediment tracking.

Based on the results of the inspection, the site description and the pollution prevention measures identified in the SWPPP shall be revised as soon as possible after an inspection that reveals inadequacies. The inspection and plan review process shall provide for timely implementation of any changes to the plan within 7 calendar days following the inspection.

An inspection report that summarizes the scope of the inspection, name(s) and qualifications of personnel conducting the inspection, the dates of the inspection, major observations relating to the implementation of the SWPPP, and actions taken shall be retained as part of the SWPPP for at least three years after the date of inspection. The report must be signed by a principal of the operator.

5.2 MAINTENANCE

Maintenance includes those procedures used to maintain vegetation, erosion and sediment control measures, and other protective measures identified in the site plan.

Maintenance shall be performed either on a interval specified in the SWPPP or when the inspection finds that it is necessary for the measure to be effective. For example, if an inspector found that sediment had accumulated in a sediment trap to the depth of one half of its storage depth, the inspector should request that the accumulated sediment be removed from the trap. Appropriate maintenance practices for erosion and sediment controls are discussed in Appendix B.

5.3 RECORDKEEPING

Inspection and maintenance forms shall be prepared prior to the start of the construction activity. The inspection forms shall be specific to the construction project and the SWPPP. The forms shall list each of the measures to be inspected on the site. The form shall include blanks for the inspector to fill in: the inspector's name, the date of inspection, the condition of the measure/area inspected, maintenance or repair performed and any changes which should be made to the SWPPP to control or eliminate pollution of storm water (See Appendix A for a sample format). The completed inspection form shall be inserted into an appendix of the SWPPP.

5.4 TRAINING

Training programs in sediment and erosion control shall be provided for inspection personnel. The inspector shall also have detailed knowledge about the site's SWPPP including the following portions:

- The location and type of control measures;
- The construction requirements for the control measures;
- Maintenance procedures for each of the control measures;
- Spill prevention and cleanup measures; and
- Inspection and maintenance recordkeeping requirements.

SECTION 6
STORM WATER MANAGEMENT CONTROLS

The SWPPP shall also address measures that will be installed during the construction process to control pollutants in storm water discharges that will occur after construction operations have been completed. Storm water management controls attempt to limit the increases in the amount of runoff and the amount of pollutants discharged from a site associated with the change in land use.

The SWPPP only addresses the installation of storm water management measures, and not the ultimate operation and maintenance of such structures after the construction activities have been completed and the site has undergone final stabilization. Permittees are only responsible for the installation and maintenance of storm water management measures prior to final stabilization of the site. They are not responsible for maintenance after storm water discharges associated with industrial activity due to construction activities have been eliminated from the site.

These measures may include:

- storm water detention structures (including wet ponds);
- storm water retention structures;
- flow attenuation by use of open vegetated swales and natural depressions;
- infiltration of runoff onsite and sequential systems (which combine several practices).

The pollution prevention plan shall include an explanation of the technical basis used to select the measures to control pollution where flows exceed predevelopment levels.

Velocity dissipation devices shall be placed at discharge locations and along the length of any outfall channel for the purpose of providing a non-erosive velocity flow from the structure to a water course so that the natural physical and biological characteristics and functions are maintained and protected (e.g., no significant changes in the hydrological regime of the receiving water).

APPENDIX A
EXAMPLE OF A SWPPP
FOR CONSTRUCTION ACTIVITIES
AND
AN EROSION AND SEDIMENT CONTROL PLAN

HOMERVILLE APARTMENTS
CONSTRUCTION POLLUTION PREVENTION PLAN

EXAMPLE 1

SITE DESCRIPTION			
Project Name and Location: (Latitude, Longitude, or Address)	Homerville Apartments 21 Broadview Avenue Center City, ANY STATE 00000	Owner Name and Address:	Quality Associates 11 Main Street Center City, ANY STATE 00000
Description: (Purpose and Types of Soil Disturbing Activities)			

This project will consist of three low-rise, attached apartment buildings with adjacent parking facilities.

Soil disturbing activities will include: clearing and grubbing; installing a stabilized construction entrance, perimeter, and other erosion and sediment controls; grading; excavation for the sedimentation pond, storm sewer, utilities, and building foundations; construction of curb and gutter, road, and parking areas; and preparation for final planting and seeding.

Runoff Coefficient:	The final coefficient of runoff for the site will be c = 0.5.
Site Area:	The site is approximately 11.0 acres of which 9.8 acres will be disturbed by construction activities.

Sequence of Major Activities

The order of activities will be as follows:

1. Install stabilized construction entrance
2. Clear and grub for earth dike and sediment basin
3. Install earth dike
4. Construct sedimentation basin
5. Continue clearing and grading
6. Pile topsoil
7. Stabilize denuded areas and stockpiles within 14 days of last construction activity in that area
8. Install utilities, storm sewer, curb and gutter
9. Apply stone to parking area and road
10. Construct apartment buildings
11. Complete grading and install permanent seeding and plantings
12. Complete final paving
13. Remove accumulated sediment from basin.
14. When all construction activity is complete and the site is stabilized, remove earth dike and reseed any areas disturbed by their removal.

Name of Receiving Waters:	The entire site will drain into Rocky Creek which is approximately one hundred yards from the site.

CONTROLS

Erosion and Sediment Controls

Stabilization Practices

Temporary Stabilization - Top soil stock piles and disturbed portions of the site where construction activity temporarily ceases for at least 21 days will be stabilized with temporary seed and mulch no later than 14 days from the last construction activity in that area. The temporary seed shall be Rye (grain) applied at the rate of 120 pounds per acre. Prior to seeding, 2,000 pounds of ground agricultural limestone and 1,000 pounds of 10-10-10 fertilizer shall be applied to each acre to be stabilized. After seeding, each area shall be mulched with 4,000 pounds per acre of straw. The straw mulch is to be tacked into place by a disk with blades set nearly straight. Areas of the site which are to be paved will be temporarily stabilized by applying geotextile and stone sub-base until bituminous pavement can be applied.

Permanent Stabilization - Disturbed portions of the site where construction activities permanently ceases shall be stabilized with permanent seed no later than 14 days after the last construction activity. The permanent seed mix shall consist of 80 lbs/acre tall fescue, and 40 lbs/acre kobe lespedeza. Prior to seeding, 4,000 pounds of ground agricultural limestone and 2,000 pounds of 10-10-10 fertilizer shall be applied to each acre to be stabilized. After seeding, each area shall be mulched with 4,000 pounds per acre of straw. The straw mulch is to be tacked into place by a disk with blades set nearly straight.

CONTROLS (Continued)

Structural Practices

Earth Dike - will be constructed along the uphill perimeter (north) of the site. A portion of the dike will divert runon around the construction site. The remaining portion of the dike will collect runoff from the disturbed area and direct the runoff to the sediment basin.

Sediment Basin - will be constructed at the common drainage location on the south side of the construction site. The basin will be formed by constructing an embankment across an existing gully and excavating a storage pond with a volume of 36,000 cubic feet (0.82) acre feet. The basin will drain through a corrugated metal riser and outlet pipe to a rip rap outlet apron. Once construction activities are nearly complete, the accumulated sediment will be removed from the basin.

Storm Water Management

Storm water drainage will be provided by curb and gutter, storm sewer and catch basin, for the developed areas. The areas which are not developed will be graded at less that 0.5:1 and have permanent seeding or plantings. Two acres of the site will remain untouched and in its natural state. When construction is complete the entire site will drain to a wet detention basin. The wet detention basin will be in the location of the temporary sediment basin. When upslope areas are stabilized, the accumulated sediment will be removed from the sediment basin, and the areas on the sides of the basin will be planted with vegetation. The wet detention pond is designed with a permanent pool volume of 0.82 (acre-feet). This is equivalent to one inch of runoff for the entire drainage area. It is expected that this wet detention pond design will result in an 80 percent removal of total suspended solids from the site's storm water runoff. The pond has been designed by a professional engineer to keep peak flow rates from the two and ten year/24 hour storms at their pre-development rates. The outlet of the detention basin will be stabilized by a riprap apron.

OTHER CONTROLS

Waste Disposal:

Waste Materials

All waste materials will be collected and stored in a securely lidded metal dumpster rented from the ADF Waste Management Company, which is a licensed solid waste management company in Center City. The dumpster will meet all local Center City and any State solid waste management regulations. All trash and construction debris from the site will be deposited in the dumpster. The dumpster will be emptied a minimum of twice per week or more often if necessary, and the trash will be hauled to the Center City Dump. No construction waste materials will be buried onsite. All personnel will be instructed regarding the correct procedure for waste disposal. Notices stating these practices will be posted in the office trailer and Mr. Doe, the individual who manages the day-to-day site operations, will be responsible for seeing that these procedures are followed.

Hazardous Waste

All hazardous waste materials will be disposed of in the manner specified by local or State regulation or by the manufacturer. Site personnel will be instructed in these practices and Mr. Doe, the individual who manages day-to-day site operations, will be responsible for seeing that these practices are followed.

Sanitary Waste

All sanitary waste will be collected from the portable units a minimum of three times per week by the TIDEE Company, a licensed Center City sanitary waste management contractor, as required by local regulation.

Offsite Vehicle Tracking:

A stabilized construction entrance has been provided to help reduce vehicle tracking of sediments. The paved street adjacent to the site entrance will be swept daily to remove any excess mud, dirt or rock tracked from the site. Dump trucks hauling material from the construction site will be covered with a tarpaulin.

TIMING OF CONTROLS/MEASURES

As indicated in the Sequence of Major Activities, the earth dike, stabilized construction entrance and sediment basin will be constructed prior to clearing or grading of any other portions of the site. Areas where construction activity temporarily ceases for more than 21 days will be stabilized with a temporary seed and mulch within 14 days of the last disturbance. Once construction activity ceases permanently in an area, that area will be stabilized with permanent seed and mulch. After the entire site is stabilized, the accumulated sediment will be removed from the trap and the earth dike will be removed.

CERTIFICATION OF COMPLIANCE WITH FEDERAL, STATE, AND LOCAL REGULATIONS

The storm water pollution prevention plan reflects Center City requirements for storm water management and erosion and sediment control, as established in Center City ordinance 5-188. To ensure compliance, this plan was prepared in accordance with the Center City Storm Water Management, Erosion and Sediment Control Handbook, published by the Center City Department of Planning, Storm Water Management Section. There are no other applicable State or Federal requirements for sediment and erosion site plans (or permits), or storm water management site plans (or permits).

MAINTENANCE/INSPECTION PROCEDURES

Erosion and Sediment Control Inspection and Maintenance Practices

These are the inspection and maintenance practices that will be used to maintain erosion and sediment controls.

- Less than one half of the site will be denuded at one time.
- All control measures will be inspected at least once each week and following any storm event of 0.5 inches or greater.
- All measures will be maintained in good working order; if a repair is necessary, it will be initiated within 24 hours of report.
- Built up sediment will be removed from silt fence when it has reached one-third the height of the fence.
- Silt fence will be inspected for depth of sediment, tears, to see if the fabric is securely attached to the fence posts, and to see that the fence posts are firmly in the ground.
- The sediment basin will be inspected for depth of sediment, and built up sediment will be removed when it reaches 10 percent of the design capacity or at the end of the job.
- Diversion dike will be inspected and any breaches promptly repaired.
- Temporary and permanent seeding and planting will be inspected for bare spots, washouts, and healthy growth.
- A maintenance inspection report will be made after each inspection. A copy of the report form to be completed by the inspector is attached.
- Mr. Doe, site superintendent, will select three individuals who will be responsible for inspections, maintenance and repair activities, and filling out the inspection and maintenance report.
- Personnel selected for inspection and maintenance responsibilities will receive training from Mr. Doe. They will be trained in all the inspection and maintenance practices necessary for keeping the erosion and sediment controls used onsite in good working order.

MAINTENANCE/INSPECTION PROCEDURES (Continued)

Non-Storm Water Discharges

It is expected that the following non-storm water discharges will occur from the site during the construction period:

- Water from water line flushings.
- Pavement wash waters (where no spills or leaks of toxic or hazardous materials have occurred).
- Uncontaminated groundwater (from dewatering excavation).

All non-storm water discharges will be directed to the sediment basin prior to discharge.

INVENTORY FOR POLLUTION PREVENTION PLAN

The materials or substances listed below are expected to be present onsite during construction:

- Concrete
- Detergents
- Paints (enamel and latex)
- Metal Studs
- Concrete
- Tar
- Fertilizers
- Petroleum Based Products
- Cleaning Solvents
- Wood
- Masonry Block
- Roofing Shingles.

SPILL PREVENTION

Material Management Practices

The following are the material management practices that will be used to reduce the risk of spills or other accidental exposure of materials and substances to storm water runoff.

Good Housekeeping:

The following good housekeeping practices will be followed onsite during the construction project.

- An effort will be made to store only enough product required to do the job
- All materials stored onsite will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure
- Products will be kept in their original containers with the original manufacturer's label
- Substances will not be mixed with one another unless recommended by the manufacturer
- Whenever possible, all of a product will be used up before disposing of the container
- Manufacturers' recommendations for proper use and disposal will be followed
- The site superintendent will inspect daily to ensure proper use and disposal of materials onsite.

Hazardous Products:

These practices are used to reduce the risks associated with hazardous materials.

- Products will be kept in original containers unless they are not resealable
- Original labels and material safety data will be retained; they contain important product information
- If surplus product must be disposed of, manufacturers' or local and State recommended methods for proper disposal will be followed.

SPILL PREVENTION (Continued)

Product Specific Practices

The following product specific practices will be followed onsite:

Petroleum Products:

All onsite vehicles will be monitored for leaks and receive regular preventive maintenance to reduce the chance of leakage. Petroleum products will be stored in tightly sealed containers which are clearly labeled. Any asphalt substances used onsite will be applied according to the manufacturer's recommendations.

Fertilizers:

Fertilizers used will be applied only in the minimum amounts recommended by the manufacturer. Once applied, fertilizer will be worked into the soil to limit exposure to storm water. Storage will be in a covered shed. The contents of any partially used bags of fertilizer will be transferred to a sealable plastic bin to avoid spills.

Paints:

All containers will be tightly sealed and stored when not required for use. Excess paint will not be discharged to the storm sewer system but will be properly disposed of according to manufacturers' instructions or State and local regulations.

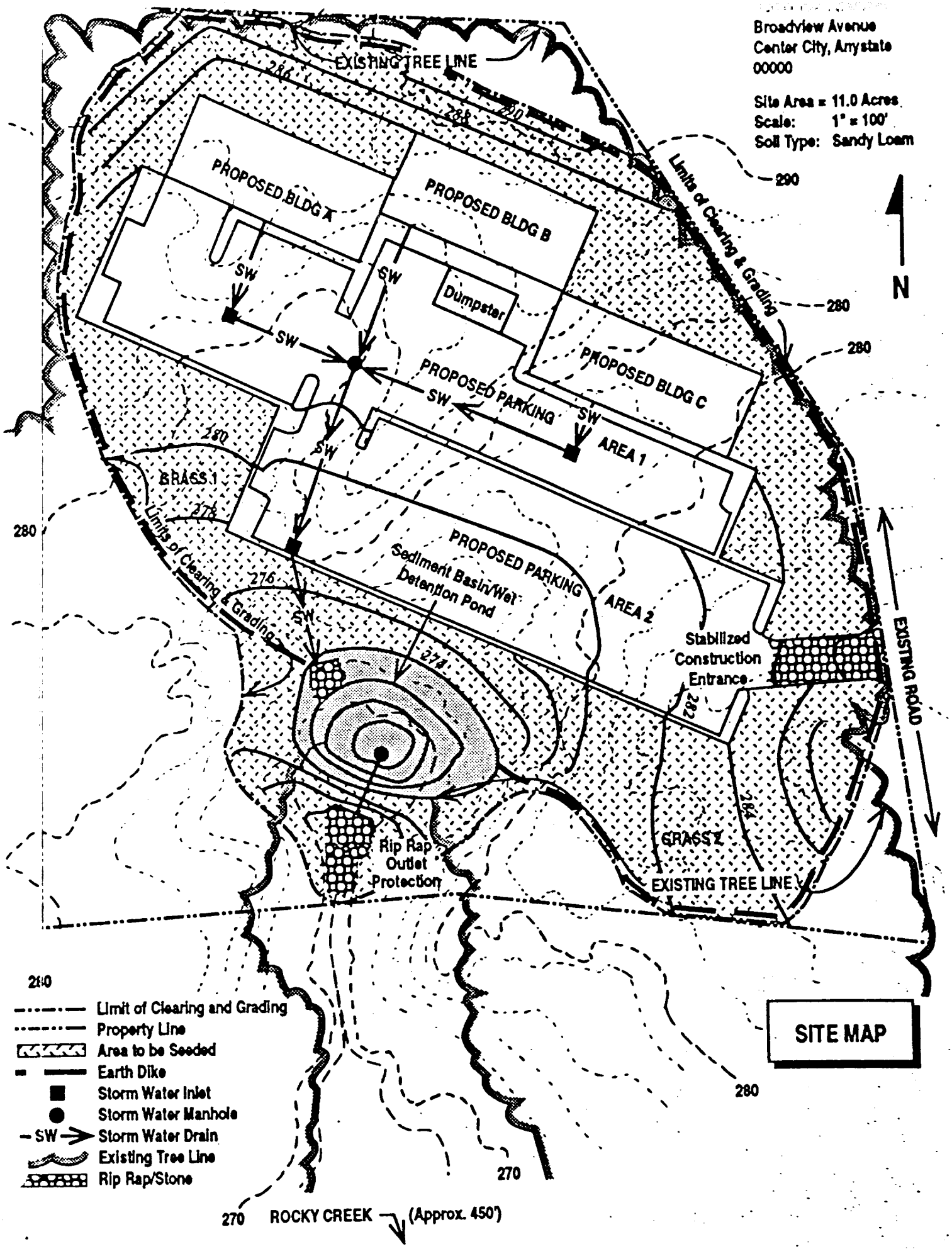
Concrete Trucks:

Concrete trucks will not be allowed to wash out or discharge surplus concrete or drum wash water on the site.

Spill Control Practices

In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices will be followed for spill prevention and cleanup:

- Manufacturers' recommended methods for spill cleanup will be clearly posted and site personnel will be made aware of the procedures and the location of the information and cleanup supplies.
- Materials and equipment necessary for spill cleanup will be kept in the material storage area onsite. Equipment and materials will include but not be limited to brooms, dust pans, mops, rags, gloves, goggles, kitty litter, sand, sawdust, and plastic and metal trash containers specifically for this purpose.
- All spills will be cleaned up immediately after discovery.
- The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with a hazardous substance.
- Spills of toxic or hazardous material will be reported to the appropriate State or local government agency, regardless of the size.
- The spill prevention plan will be adjusted to include measures to prevent this type of spill from reoccurring and how to clean up the spill if there is another one. A description of the spill, what caused it, and the cleanup measures will also be included.
- Mr. Doe, the site superintendent responsible for the day-to-day site operations, will be the spill prevention and cleanup coordinator. He will designate at least three other site personnel who will receive spill prevention and cleanup training. These individuals will each become responsible for a particular phase of prevention and cleanup. The names of responsible spill personnel will be posted in the material storage area and in the office trailer onsite.


Broadview Avenue
Center City, Anystate
00000
Site Area = 11.0 Acres
Scale: 1" = 100'
Soil Type: Sandy Loam
N
EXISTING TREE LINE
PROPOSED BLDG A
PROPOSED BLDG B
PROPOSED BLDG C
Dumpster
PROPOSED PARKING AREA 1
PROPOSED PARKING AREA 2
Limits of Clearing & Grading
GRASS 1
GRASS 2
Sediment Basin/Wet Detention Pond
Stabilized Construction Entrance
EXISTING ROAD
Rip Rap Outlet Protection
SW
290
280
270
ROCKY CREEK
(Approx. 450')
Limit of Clearing and Grading
Property Line
Area to be Seeded
Earth Dike
Storm Water Inlet
Storm Water Manhole
Storm Water Drain
Existing Tree Line
Rip Rap/Stone
SITE MAP

POLLUTION PREVENTION PLAN CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signed:_____
John R. Quality,
President
Quality Associates

Date:_____

CONTRACTOR'S CERTIFICATION

I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit that authorizes the storm water discharges associated with industrial activity from the construction site identified as part of this certification.

Signature	For	Responsible for
_____ Joseph Contractor, President Date:_____	Center City Const., Inc. 21 Elm Street Center City, Any State 00000 (123) 399-8765	General Contractor
_____ John Planter Vice President of Construction Date:_____	Green Grass, Inc. 4233 Center Road Outerville, Any State 00001 (123) 823-5678	Temporary and Permanent Stabilization
_____ Jim Kay, President Date:_____	Dirt Movers, Inc. 523 Lincoln Ave. Outerville, Any State 00001 (123) 823-8921	Stabilized Construction Entrance, Earth Dikes, Sediment Basin

HOMERVILLE APARTMENTS

STORM WATER POLLUTION PREVENTION PLAN

INSPECTION AND MAINTENANCE REPORT FORM

TO BE COMPLETED EVERY 7 DAYS AND WITHIN 24 HOURS OF
A RAINFALL EVENT OF 0.5 INCHES OR MORE

INSPECTOR:_____ DATE:_____

INSPECTOR'S QUALIFICATIONS:

_____

_____

_____

_____

DAYS SINCE LAST RAINFALL: _____ AMOUNT OF LAST RAINFALL _____ INCHES

STABILIZATION MEASURES

AREA	DATE SINCE LAST DISTURBED	DATE OF NEXT DISTURBANCE	STABILIZED? (YES/NO)	STABILIZED WITH	CONDITION
BLDG. A					
BLDG. B					
BLDG. C					
PRKNG. 1					
PRKNG. 2					
GRASS 1					
GRASS 2					

STABILIZATION REQUIRED:

_____

_____

_____

_____

TO BE PERFORMED BY: _____ ON OR BEFORE:_____

HOMERVILLE APARTMENTS

STORM WATER POLLUTION PREVENTION PLAN

INSPECTION AND MAINTENANCE REPORT FORM

STRUCTURAL CONTROLS

DATE: _____

EARTH DIKE:

FROM	TO	IS DIKE STABILIZED?	IS THERE EVIDENCE OF WASHOUT OR OVER-TOPPING?
BUILDING B	STABILIZED CONSTRUCTION ENTRANCE		
STABILIZED CONSTRUCTION ENTRANCE	SEDIMENT BASIN		
BUILDING B	SEDIMENT BASIN		

MAINTENANCE REQUIRED FOR EARTH DIKE:

_____

_____

_____

_____

TO BE PERFORMED BY: _____ ON OR BEFORE: _____

HOMERVILLE APARTMENTS

STORM WATER POLLUTION PREVENTION PLAN

INSPECTION AND MAINTENANCE REPORT FORM

SEDIMENT BASIN:

DEPTH OF SEDIMENT IN BASIN	CONDITION OF BASIN SIDE SLOPES	ANY EVIDENCE OF OVERTOPPING OF THE EMBANKMENT?	CONDITION OF OUTFALL FROM SEDIMENT BASIN

MAINTENANCE REQUIRED FOR SEDIMENT BASIN:

_____

_____

_____

_____

TO BE PERFORMED BY: _____ ON OR BEFORE: _____

OTHER CONTROLS

STABILIZED CONSTRUCTION ENTRANCE:

DOES MUCH SEDIMENT GET TRACKED ON TO ROAD?	IS THE GRAVEL CLEAN OR IS IT FILLED WITH SEDIMENT?	DOES ALL TRAFFIC USE THE STABILIZED ENTRANCE TO LEAVE THE SITE?	IS THE CULVERT BENEATH THE ENTRANCE WORKING?

MAINTENANCE REQUIRED FOR STABILIZED CONSTRUCTION ENTRANCE:

_____

_____

_____

_____

TO BE PERFORMED BY: _____ ON OR BEFORE: _____

STORM WATER POLLUTION PREVENTION PLAN

INSPECTION AND MAINTENANCE REPORT FORM

CHANGES REQUIRED TO THE POLLUTION PREVENTION PLAN:

_____

_____

_____

_____

REASONS FOR CHANGES:

_____

_____

_____

_____

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

SIGNATURE:_____ DATE:_____

EXAMPLE 2

NARRATIVE DESCRIPTION OF AN EROSION AND SEDIMENT CONTROL PLAN

(Fictional)

DESCRIPTION: Phase I of this proposed development is located on Hwy. 76,1.2 miles west of Lexington, Georgia, and contains 21.34 acres. This area will be developed for use as a public school facility. Improvements will consist of a 28,800-square-foot school building, a 13,500-square-foot gymnasium, .88 acres of parking, a football field, a one acre playground, and service roads. Phase II, which comprises approximately 83.7 acres, will contain single family residences and will be developed at a later date.

ZONING: The present zoning classification of Phase I is Office-Institutional (O-I). (See zoning sketch of drawing Number 1 for zoning classifications of adjacent properties.)

DATES OF CONSTRUCTION: Initial construction was scheduled to begin April 1,1991. Final stabilization was accomplished before May 15,1992.

SOILS, TOPOGRAPHIC AND DRAINAGE INFORMATION: (For soils, topographic and drainage information, see drawing Number 1.)

VEGETATION: (For a description of existing vegetation, see drawing Number 1.) All marketable timber will be salvaged. Top soil will be salvaged, stockpiled and spread on areas to be vegetated. Trees outside of the clearing line will be protected from damage by appropriate markings. (See drawing Number 1 for clearing information and vegetative plan.) Supplemental vegetation will be established.

BUFFER REQUIREMENTS: An undisturbed natural vegetative buffer of 25 feet measured from the stream banks (100 feet measured horizontally, adjacent to trout streams) shall normally be retained adjacent to any state waters except where otherwise required by Part 6 of Article 5 of Chapter 5 of this title, the "Metropolitan River Protection Act," or by the department pursuant to Code Section 12-2-8, or when the economic use and the contour of the land require a different buffer subject to the division's approval, or where a drainage structure must be constructed, provided that adequate erosion control measures are incorporated in the project plans and specifications are implemented.

EROSION CONTROL PROGRAM: Clearing will be kept to an absolute minimum. Vegetation and mulch will be applied to applicable areas immediately after grading is completed. Gravel will be applied to parking areas and roadways as soon as grading is completed. Land-disturbing will be scheduled to limit exposure of bare soils to erosive elements. Storm water management structures will be employed to prevent erosion in areas of concentrated water flows. Erosion at the exits of all stormwater structures will be prevented by the installation of storm drain outlet protection devices.

SEDIMENT CONTROL PROGRAM: Sediment control will be accomplished by the installation of two sediment basins, approximately 550 linear feet of sediment fences and 375 feet of temporary brush barriers. Diversions will be installed to divert sediment laden runoff into the sediment basins and to protect cut and fill slopes from erosive water flow. A temporary construction exit will be employed to prevent the transport of sediment from the site by vehicular traffic.

STANDARDS AND SPECIFICATIONS: All designs will conform to and all work will be performed in accordance with the Standards and Specifications of the publication entitled "Manual for Erosion and Sediment Control in Georgia." (See attached calculations).

SAFETY PROTECTION: Construction activities will be performed in compliance with all applicable laws, rules and regulations. Sediment basin number II, which will be converted to a storm water detention structure, will be posted and fenced to exclude children.

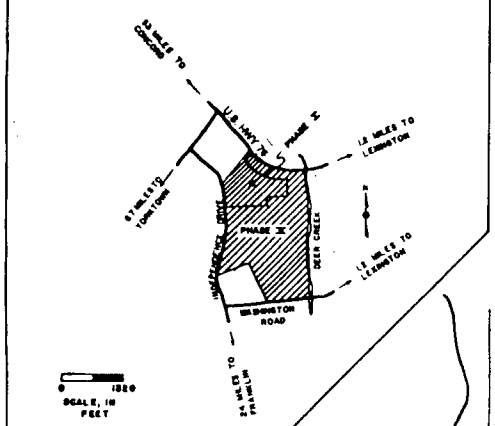
MAINTENANCE PROGRAM: Sediment and erosion control measures will be inspected daily. Any damages observed will be repaired by the end of that day. Cleanout of sediment control structures will be accomplished in accordance with the specifications and sediment disposal accomplished by spreading on the site. Sediment basins and barriers will remain in place until sediment contributing areas are stabilized. The sediment basin, sediment fences, and the barriers will then be removed and the areas occupied by these structures vegetated. Sediment from the detention basin will be removed and this basin converted to a storm water detention structure. Guidelines for the maintenance of established vegetation will be provided to the owner when all disturbed areas are stabilized.

FLOOD DAMAGE PREVENTION: Land-disturbing activities shall not be conducted within the 100-year flood plain unless compliance with any applicable local flood plain management ordinance is demonstrated or flood storage compensation for flood waters is provided or such construction is in compliance with the Federal Emergency Management Agency regulations.

24-HOUR CONTACT PERSON: The telephone number of a person responsible for the project's erosion and sediment control program must be provided.

Drawing I
Soils, Vegetation, and Drainage

SITE LOCATION SKETCH



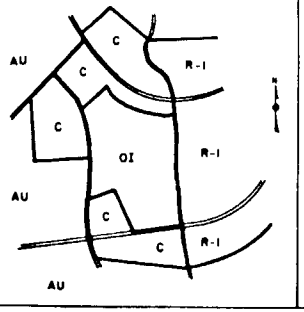
LEGEND

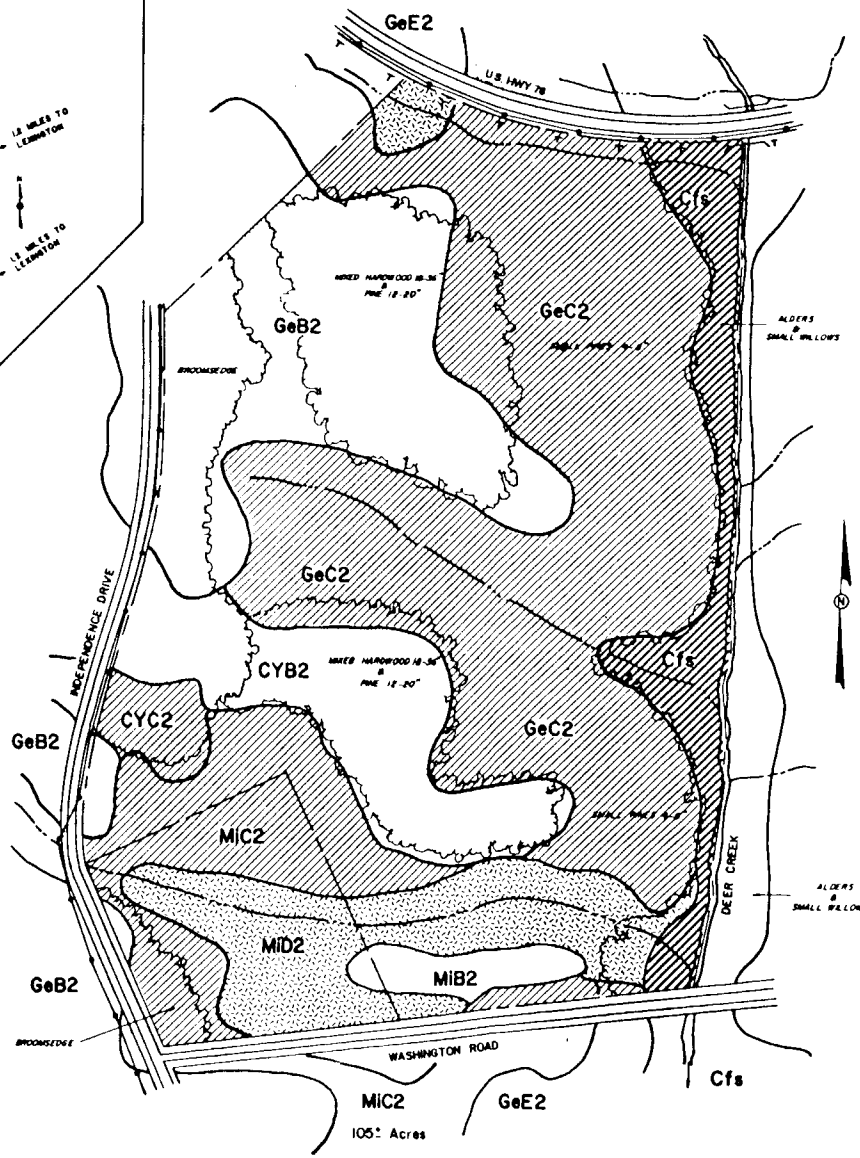
STREAMS
- Perennial
- Intermittent

PROPERTY LINE
POWER LINE
TELEPHONE LINE
SOIL BOUNDARY
SOIL SYMBOL — GYCR
VEGETATION

ZONING SKETCH

AU - AGRICULTURAL, URBAN
C - COMMERCIAL
R-I - RESIDENTIAL
OI - OFFICE, INSTITUTIONAL





SOILS INFORMATION

SOIL SYMBOL	NAME	SLOPE %	K	LIMITATION	SYMBOL	REASONS FOR LIMITATIONS
Cfs	Chewacla	0-2	.32	Severe		Very frequent flooding; high seasonal water table
CYB2	Cecil Sandy Loam	2-6	.32	Slight		
GeB2	Gwinnett Clay Loam	2-6	.28	Slight		
GeC2	Gwinnett Clay Loam	6-10	.28	Moderate		Slopes
GeE2	Gwinnett Clay Loam	10-25	.28	Severe		Slopes
MiC2	Madison Sandy Clay Loam	6-10	.32	Moderate		Slopes; moderate shrink-swell potential
MiD2	Madison Sandy Clay Loam	10-15	.32	Severe		Slopes

Seal

Certification

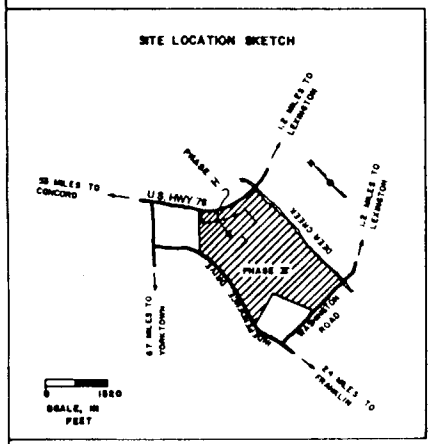
INDEPENDENCE DEVELOPMENT

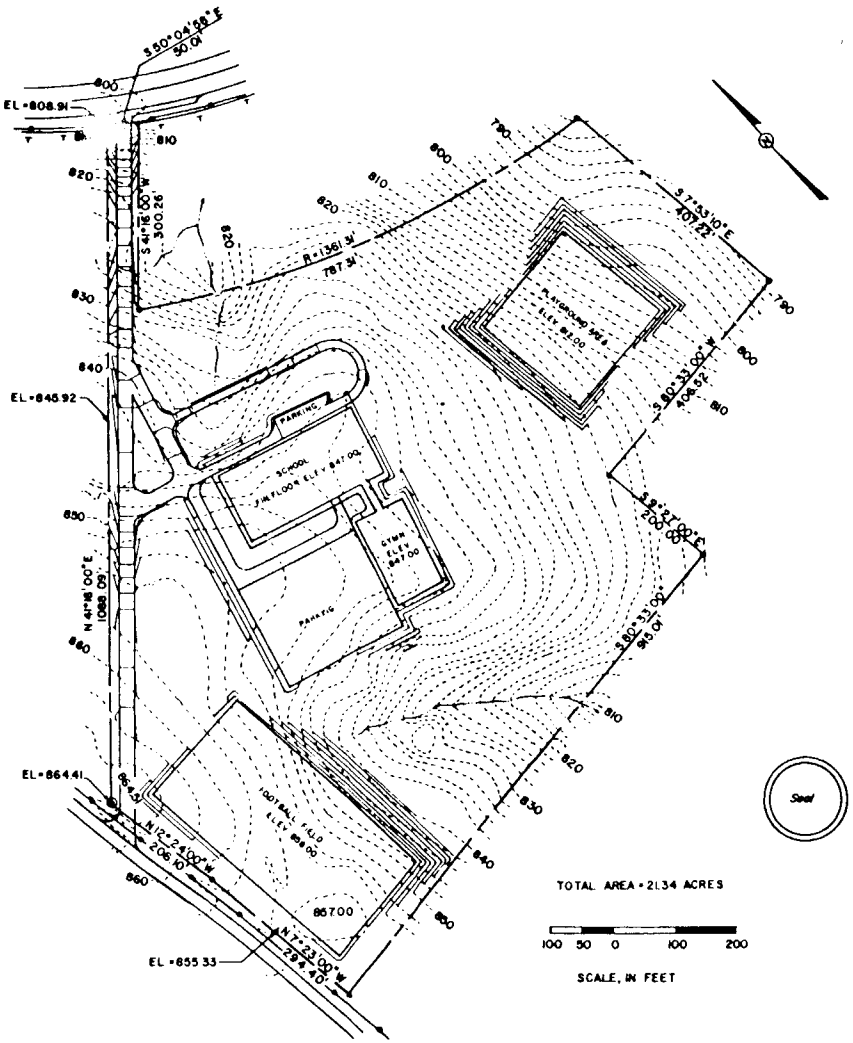
BILL PENN
CONSULTING PLANNERS AND ENGINEERS

OWNER: G. WASHINGTON	COUNTY, STATE: GWINNETT, GEORGIA
DRAWN BY: TOM JEFFERSON	LAND LOT: 200
DATE: JULY 4, 1990	LAND DISTRICT: 28th

GaSWCC

Drawing 2
Detailed Boundary Line and Topographic Survey With Fixed Improvements





TOTAL AREA = 21.34 ACRES

100 50 0 100 200

SCALE, IN FEET

LEGEND

INTERMITTENT STREAM	~ ~ ~
IRON PIN FOUND	●
PROPERTY LINE	— — —
TEMPORARY BENCH MARK	▲
POWER LINE	—o—o—
TELEPHONE LINE	T T T T
CONTOUR LINE, EXISTING	~ ~ ~
CONTOUR LINE, FINISH	———

Seal

Certification

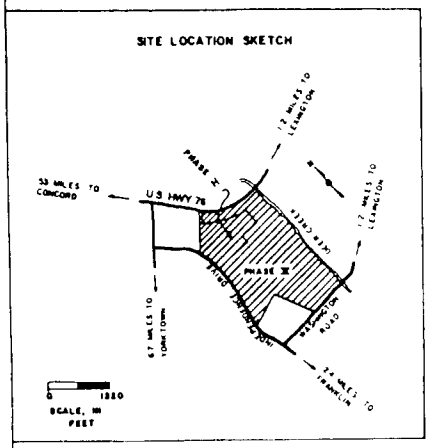
NOTE: SLOPE PARKING LOT AREA TO DRAIN AWAY FROM MAIN SCHOOL BUILDING ON 10% GRADE AND TOWARD CENTERLINE OF LOT ON 05% GRADE

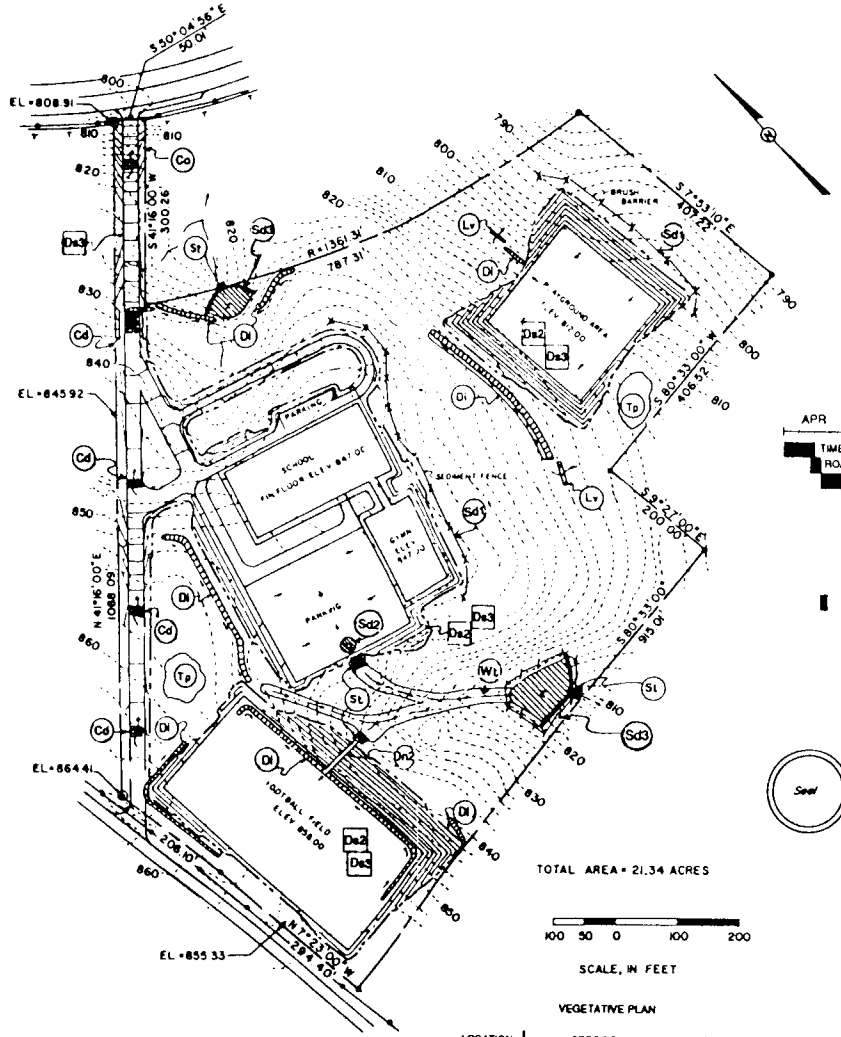
CROWN FOOTBALL FIELD 15 FEET AT CENTER

SLOPE PLAYGROUND AREA TO DRAIN TOWARD CENTERLINE ORIENTED NORTH-SOUTH

INDEPENDENCE SCHOOL	
BILL PENN CONSULTING PLANNERS AND ENGINEERS	
OWNER: G. WASHINGTON	COUNTY, STATE: GWINNETT, GEORGIA
DRAWN BY: TOM JEFFERSON	LAND LOT: 200
DATE: JULY 4, 1990	LAND DISTRICT: 28TH

Drawing 3
Erosion and Sediment Control Plan





LEGEND

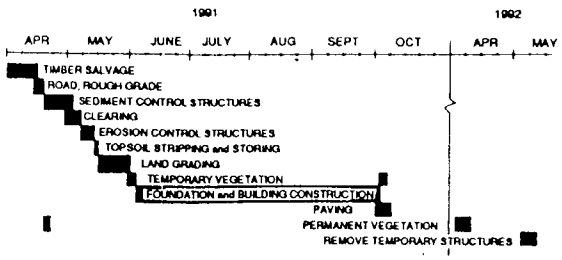
- INTERMITTENT STREAM
- IRON PIN FOUND
- PROPERTY LINE
- TEMPORARY BENCH MARK
- POWER LINE
- TELEPHONE LINE T T T T
- CONTOUR LINE, EXISTING
- CONTOUR LINE, FINISH
- CLEARING LIMIT LINE

TOTAL AREA = 21.34 ACRES

100 50 0 100 200

SCALE, IN FEET

CONSTRUCTION SCHEDULE



Seal

Certification

VEGETATIVE PLAN

LOCATION	SPECIES	DATE
Football Field & Playground	Sudangrass	June '91
	Hulled Common Bermudagrass	April '92
Roadside	Hulled Common Bermudagrass & Virgata Lespedeza	April '91
Waterway	Sod Common Bermudagrass	April '91
School	Ryegrass	Oct '91

NOTE: SLOPE PARKING LOT AREA TO DRAIN AWAY FROM MAIN SCHOOL BUILDING ON 10% GRADE AND TOWARD CENTERLINE OF LOT ON 0.5% GRADE

CROWN FOOTBALL FIELD 1.5 FEET AT CENTER

SLOPE PLAYGROUND AREA TO DRAIN TOWARD CENTERLINE ORIENTED NORTH-SOUTH

INDEPENDENCE SCHOOL

BILL PENN
CONSULTING PLANNERS AND ENGINEERS

OWNER: G WASHINGTON	COUNTY, STATE: GWINNETT, GEORGIA
DRAWN BY: TOM JEFFERSON	LAND LOT: 200
DATE: JULY 4, 1990	LAND DISTRICT: 26th

APPENDIX B
STANDARDS AND SPECIFICATIONS
FOR LAND DISTURBING ACTIVITIES

APPENDIX B
STANDARDS AND SPECIFICATIONS

SECTION I: STRUCTURAL PRACTICES

(Cd) Checkdam 6-13
(Ch) Channel Stabilization 6-17
(Co) Construction Exit 6-21
(Di) Diversion 6-23
(Dn1) Temporary Downdrain Structure 6-43
(Dn2) Permanent Downdrain Structure 6-45
(Ga) Gabion 6-51
(Gr) Grade Stabilization Structure 6-53
(Lv) Level Spreader 6-63
(Rd) Rock Filter Dam 6-65
(Re) Retaining Wall 6-67
(Rt) Retrofitting 6-69
(Sd1) Sediment Barrier 6-73
(Sd2) Inlet Sediment Trap 6-83
(Sd3) Temporary Sediment Basin 6-89
(Sr) Temporary Stream Crossing 6-113
(St) Storm Drain Outlet Protection 6-117
(Su) Surface Roughening 6-125
(Tp) Topsoiling 6-129
(Wt) Vegetated Waterway or Storm Water Conveyance Channel 6-131

SECTION II: VEGETATIVE MEASURES

[Bf] Buffer Zone 6-155
[Cs] Coastal Dune Stabilization 6-157
[Ds1] Disturbed Area Stabilization (with Mulching Only) 6-161
[Ds2] Disturbed Area Stabilization (with Temporary Seeding) 6-163
[Ds3] Disturbed Area Stabilization (with Permanent Vegetation) 6-167
[Du] Dust Control on Disturbed Areas 6-183

Check Dam

Cd

DEFINITION

Small temporary barrier, grade control structure, or dam constructed across a swale, drainage ditch, or areas of concentrated flow.

PURPOSE

To prevent erosion by reducing the velocity of storm water in areas of concentrated flow.

CONDITIONS

This practice is applicable for use in small open channels and is not to be used in a live stream. Specific applications include:

1. Temporary or permanent swales or ditches in need of protection during establishment of grass linings.
2. Temporary or permanent swales or ditches which, due to their short length of service or other reasons, cannot receive a pe.manent non-erodible lining for an extended period of time.
3. Other locations where small localized erosion and resulting sedimentation problems exist.

DESIGN CRITERIA

Formal design is not required. The following standards shall be used:

Drainage area: Not more than 5 acres.

Height: Center of check dam must be at least 9 inches lower than outer edges. Dam height should be 2 feet maximum measured to center of check dam.

Side slopes: 2:1 or flatter.

Spacing: Two or more check dams in series may be required for drainage areas greater than one acre. Maximum spacing between dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam. (See Figure 6-1.1)

CONSTRUCTION SPECIFICATIONS

The following types of check dams are used for this standard:

1. Stone check dams should be constructed of graded size 2-10 inch stone. (See Figure 6-1.2). Mechanical or hand placement shall be required to insure complete coverage of entire width of ditch or swale and that center of dam is lower than edges.
2. Haybale check dams: Staked and embedded haybales may be used as temporary check dams in concentrated flow areas while vegetation is becoming established. They should not be used where the drainage area exceeds 2 acres. Haybales should be embedded a minimum of 4 inches. (See Figure 6-1.3).

MAINTENANCE

Periodic inspection and required maintenance must be provided. Sediment should be removed when it reaches a depth of one-half the original dam height or before. Check dams must be removed at the completion of their useful life. After removal, the area beneath the dam should be seeded and mulched immediately.

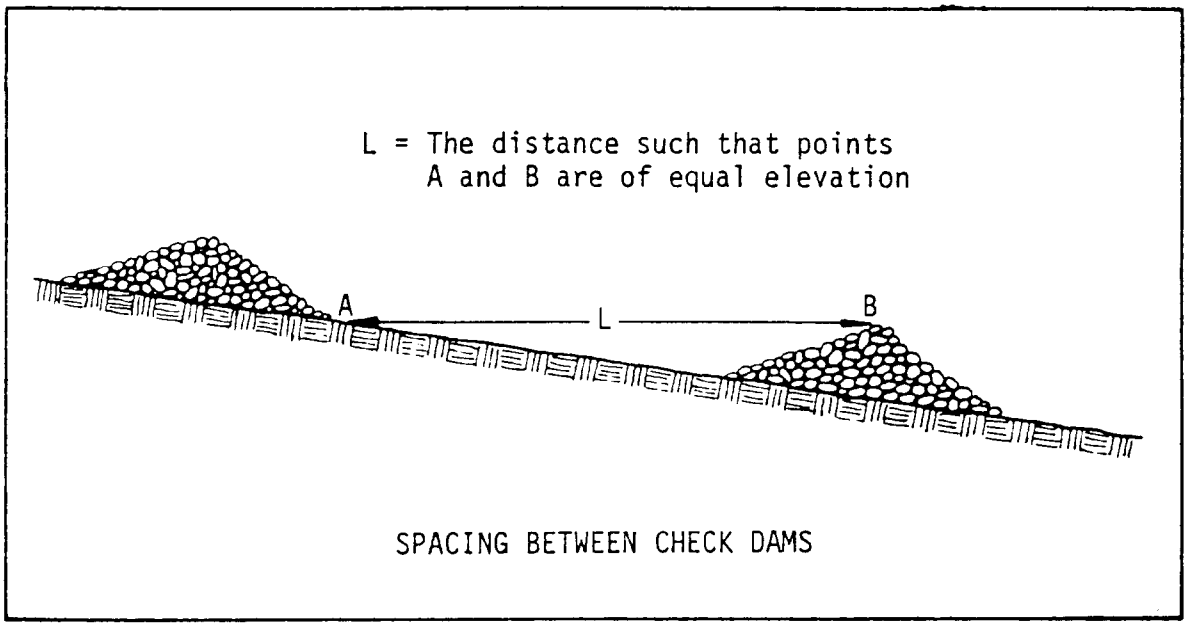


Figure 6-1.1

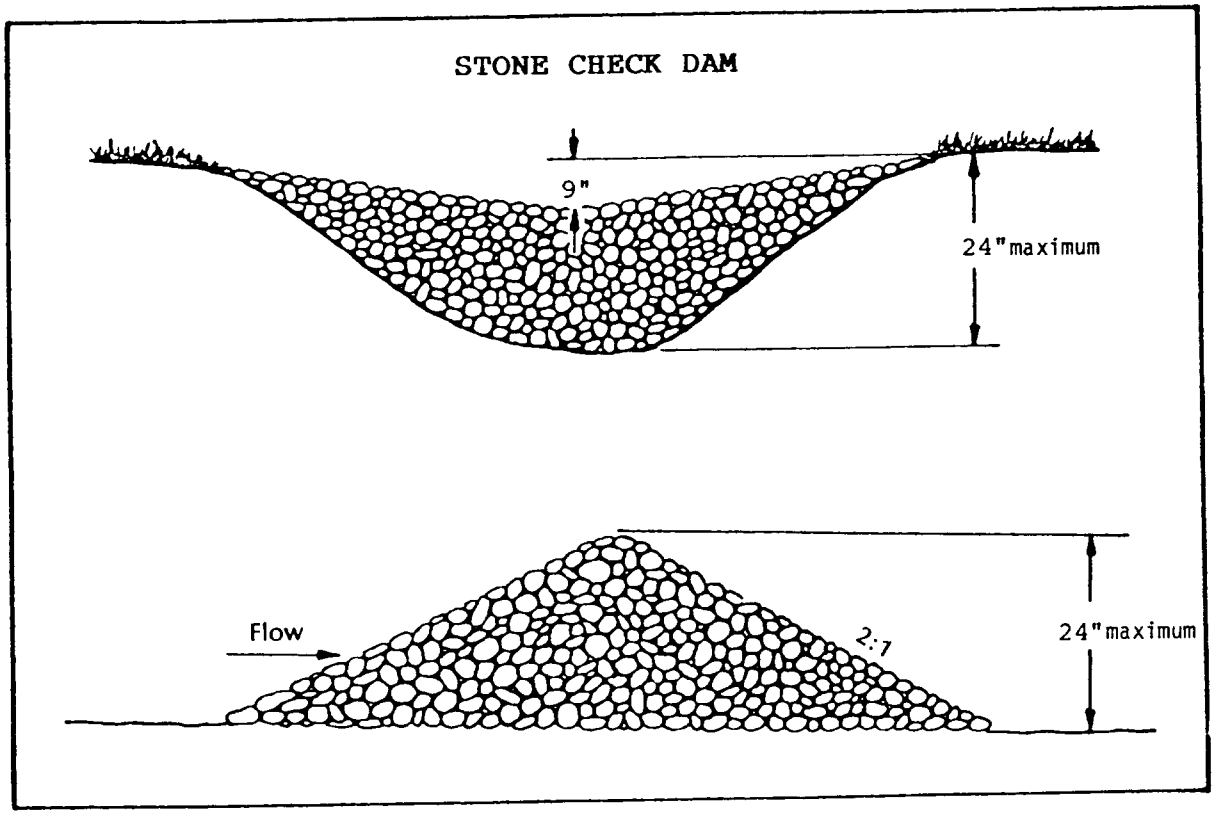
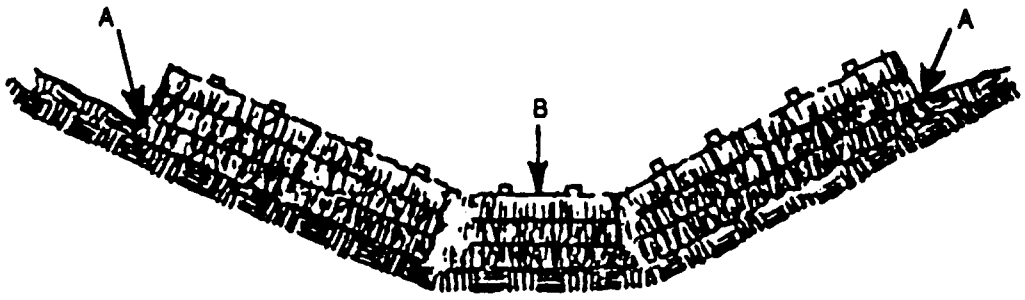
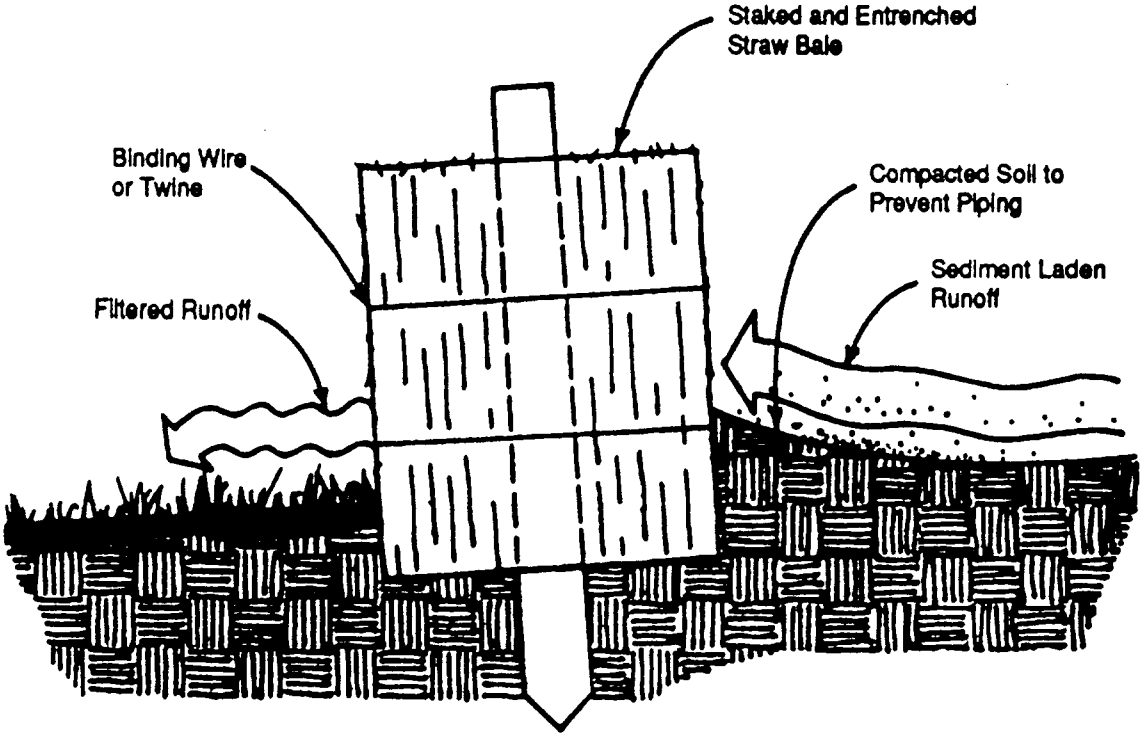


Figure 6-1.2



Points A should be higher than point B

PROPER PLACEMENT OF STRAW BALE BARRIER IN DRAINAGE WAY



Note: Embed hay bales a minimum of 4 inches.

CROSS-SECTION OF A PROPERLY INSTALLED STRAW BALE

Figure 6-1.3

Channel Stabilization

Ch

DEFINITION

Improving, constructing or stabilizing an open channel for water conveyance.

PURPOSE

Open channels are constructed or stabilized to be non-erosive and provide adequate capacity for flood water, drainage, other water management practices, or any combination thereof.

CONDITIONS

This standard applies to the improvement, construction or stabilization of open channels and existing streams or ditches with drainage areas less than one square mile.

An adequate outlet for the modified channel length must be available for discharge by gravity flow. Construction or other improvements of the channel should not adversely affect the environmental integrity of the area and must not cause significant erosion upstream or flooding and/or sediment deposition downstream.

DESIGN CRITERIA

Planning

The alignment and design of channels shall give careful consideration to the preservation of valuable fish and wildlife habitat and trees of significant value for wildlife food or shelter or for aesthetic purposes.

Where channel construction will adversely affect significant fish or wildlife habitat, mitigation measures should be included in the plan. Mitigation measures may include pools, riffles, flats, cascades or other similar provisions.

As many trees as possible are to be left inside channel rights-of-way considering the requirements of construction, operation, and maintenance.

Unusually large or beautiful trees shall be saved.

Realignment

The realignment of channels shall be kept to an absolute minimum and should be permitted only to correct an adverse environmental condition.

Channel Capacity

The capacity for open channels shall be determined by procedures applicable to the purposes to be served.

Hydraulic Requirements

Manning's formula shall be used to determine velocities in channels.

The "n" values for use in this formula shall be estimated using currently accepted guides along with knowledge and experience regarding the conditions.

Acceptable guides can be found in hydrology textbooks.

Channel Cross Section

The required channel cross section and grade are determined by the design capacity, the materials in which the channel is to be constructed, and the requirements for maintenance. A minimum depth may be required to provide adequate outlets for subsurface drains and tributary channels.

Channel Stability

All channel construction, improvement and modification shall be in accord with a design expected to result in a stable channel which can be maintained.

Characteristics of a stable channel are:

1. It neither aggrades nor degrades beyond tolerable limits.
2. The channel banks do not erode to the extent that the channel cross section is changed appreciably.
3. Excessive sediment bars do not develop.
4. Excessive erosion does not occur around culverts, bridges or elsewhere.
5. Gullies do not form or enlarge due to the entry of uncontrolled surface flow to the channel.
6. The determination of channel stability considers "bankfull" flow. Bankfull flow is defined as flow in the

channel which creates a water surface that is at or near normal ground elevation for a significant length of a channel reach. Excessive channel depth created by cutting through high ground should not be considered in determinations of bankfull flow.

CHANNEL LININGS AND STRUCTURAL MEASURES:

Where channel velocities exceed safe velocities for vegetated lining due to increased grade or a change in channel cross section, or where durability of vegetative lining is adversely affected by seasonal changes, channel linings of rock, concrete or other durable material may be needed. Grade stabilization structures may also be needed.

Channels may be stabilized by using one or more of the following methods:

Rock Riprap Lining

Rock riprap shall be designed to resist displacement when the channel is flowing at the bankfull discharge or 25-year frequency discharge whichever is the lesser.

Dumped and machine placed riprap should not be installed on slopes steeper than 1-1/2 horizontal to 1 vertical.

A filter blanket of sand and/or gravel or geotextile material shall be placed between the riprap and base material. The filter blanket material shall be at least 6 inches thick with a gradation that is consistent with the base material and the riprap.

Rock shall be dense, resistant to the action of air and water, and suitable in all other respects for the purpose intended. Rock shall be installed according to riprap standards, Appendix C.

Concrete Lining

Concrete linings shall be designed according to currently accepted guides for structural and hydraulic adequacy. They must be designed to carry the required discharge and to withstand the loading imposed by site conditions. Concrete linings should be considered for all channel velocities exceeding 10 ft/sec.

Grade Stabilization Structures

Grade stabilization structures are used to reduce or prevent excessive erosion by reduction of velocities in the watercourse or by providing structures that can withstand and reduce the higher velocities.

They may be constructed of concrete, rock, masonry, steel, aluminum or treated wood.

These structures are constructed where the capability of earth and vegetative measures is exceeded in the safe handling of water at permissible velocities, where excessive grades or overall conditions are encountered or where water is to be lowered structurally from one elevation to another. These structures should generally be planned and installed along with or as a part of other erosion control practices.

The structures must be designed hydraulically to adequately carry the channel discharge and structurally to withstand loadings imposed by the site conditions. The structure shall meet requirements of grade stabilization structure, Gr.

INSTALLATION REQUIREMENTS

1. Where needed, all trees, brush, stumps and other objectionable materials shall be removed so they will not interfere with the construction or proper functioning of the channel.
2. Where possible, trees will be left standing, and stumps will not be removed.
3. Excavation shall be at the locations and grades shown on the drawings.
4. Construction plans will specifically detail the location and handling of spoils. Spoil material resulting from clearing, grubbing and channel excavation shall be disposed of in a manner which will:
   a. not cause an increase in flood stage,
   b. minimize overbank wash,
   c. not cause an adverse effect on the environmental integrity of the area,
   d. provide for the free flow of water between the channel and flood plain unless the valley routing and water surface profile are based on continuous dikes being installed,
   e. leave the right-of-way in the best condition feasible, and
   f. improve the aesthetic appearance of the site to the extent feasible.
5. Channel linings shall be established or installed immediately after construction or as soon as weather conditions permit.
6. Structures shall be installed according to lines and grades shown on the plan. The foundation for structures shall be cleared of all undesirable materials prior to the installation of the structures.
7. Materials used in construction shall be of permanency commensurate with the design frequency and life expectancy of the facility.
8. Earthfill, when used as a part of the structures, shall be placed according to the installation requirements for sediment basin embankments.
9. Construction operations shall be carried out in such a manner that erosion and air and water pollution will be minimized. State and local laws concerning pollution abatement shall be complied with.
10. Vegetation shall be established on all disturbed areas immediately after construction, weather permitting. If weather conditions cause a delay in establishing vegetation, the area shall be mulched in accordance with the standard for mulching. Seeding, fertilizing and mulching shall conform to the standard for permament vegetative cover. If weather conditions cause a delay in establishing vegetation, the area shall be mulched in accordance with the standards for mulching.

11. All temporary access roads or travelways shall be appropriately closed to exclude traffic.
12. Trees and other fallen natural vegetation not causing a deterrent to stream flow should be left for the purpose of fish habitat.
13. Construction work in the stream should be done after consultation with the State Game and Fish Division of the Department of Natural Resources.

Construction Exit

Co

DEFINITION

A stone stabilized pad located at any point where traffic will be leaving a construction site to a public right-of-way, street, alley, sidewalk or parking area.

PURPOSE

To reduce or eliminate the transport of mud from the construction area onto public rights-of-way by motor vehicles or by runoff.

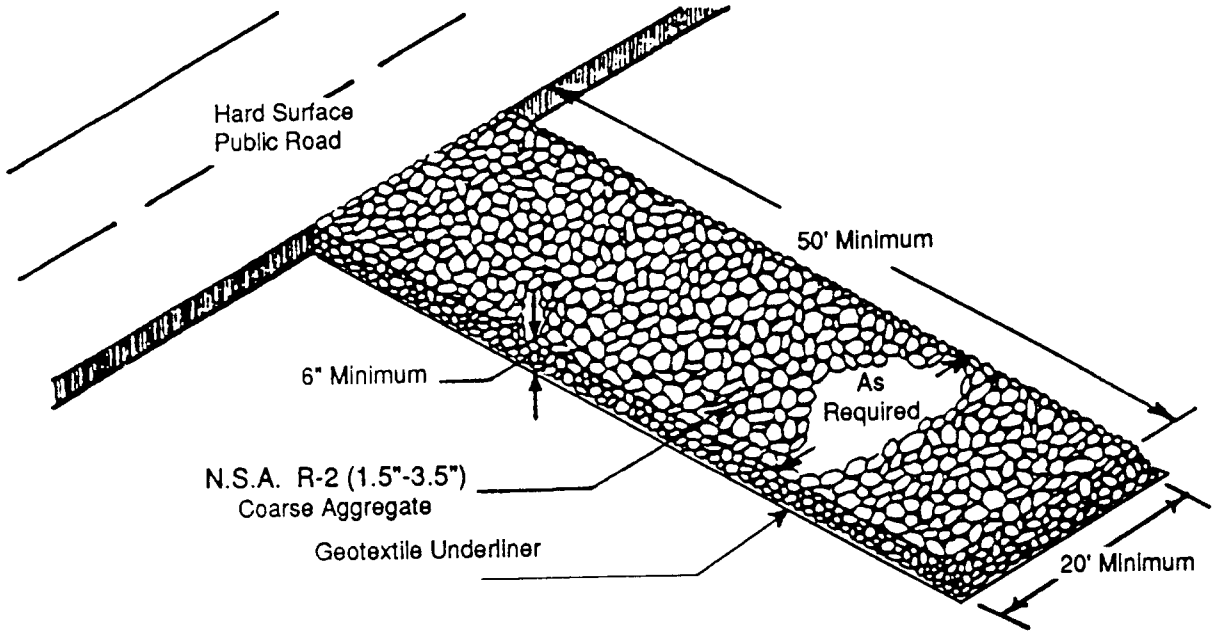
CONDITIONS

This practice is applied at appropriate points of construction egress. Geotextile underliners are required to stabilize and support the pad aggregates.

DESIGN CRITERIA

Aggregate size: Will be in accordance with National Stone Association R-2 (1.5 to 3.5 inch stone).
Pad thickness: 6-inch minimum.
Pad width: At a minimum, should equal full width of all points of vehicular egress, but not less than 20 feet wide.
Washing: Wheels must be cleaned to remove mud prior to entrance onto public rights-of-way. When washing is required, it shall be done on an area stabilized with crushed stone which drains into an approved sediment trap or sediment basin.
Location: The exit shall be located or protected to prevent sediment from leaving the site.

Maintenance: The exit shall be maintained in a condition which will prevent tracking or flow of mud onto public rights-of-way. This may require periodic top dressing with 1.5-3.5 inch stone, as conditions demand, and repair and/or cleanout of any structures used to trap sediment. All materials spilled, dropped, washed, or tracked from vehicles or site onto roadways or into storm drains must be removed immediately.



CRUSHED STONE CONSTRUCTION EXIT

Figure 6-3.1

Diversion

Di

DEFINITION

A ridge of compacted soil, constructed above, across or below a slope.

PURPOSE

To reduce slope lengths, intercept storm runoff and divert it to a stable outlet at a non-erosive velocity.

CONDITIONS

Diversions are applicable when:

1. Runoff from higher areas is or has potential for damaging property, causing erosion, contributing to pollution, flooding, interfering with or preventing the establishment of vegetation on lower areas.
2. Surface and/or shallow subsurface flow is damaging sloping upland.
3. The length of slope needs to be reduced so that soil loss will be reduced to a minimum.

This standard applies to temporary and permanent diversions in developments involving land disturbing activities.

DESIGN CRITERIA

Location

Diversion location shall be determined by considering outlet conditions, topography, land use, soil type, length of slope, seep planes (when seepage is a problem), and the development layout.

Design of Parabolic Grass-Lined Diversions

The peak runoff storm frequency to be used is shown in Table 6-4.1 . The channel must be designed for capacity and stability. The capacity will be adequate to carry the peak runoff of the design storm when the grass is tall. The design for maximum permissible velocity shall be based on the height of the plant when mowed. Refer to Table 6-4.2 for the maximum permissible velocity and retardance values for various types of vegetative covers. Design Tables 6-4.3 and 6-4.4 provide capacities and velocities for a range of slopes and retardances.

This approach provides a channel design having capacity for tall unmowed grass with a velocity V2. The velocity V1, for the mowed height, should never exceed that shown in Table 6-4.2.

Use the following procedure to design a grasslined channel based upon Table 6-4.3 or Table 6-4.4.

1. Determine the required channel capacity, Q (Peak rate of runoff from the selected design storm).
2. Select an appropriate grass lining and note the permissible velocity (V1) from Table 6-4.2.
3. Choose the appropriate sheet of Table 6-4.3 or Table 6-4.4 for the channel slope. Using a velocity not greater than the maximum permissible velocity (V1) and the required capacity (Q), read the top width (T) and the depth (D) for the correct parabolic section. Note that for any given "Q" and channel grade, there may be several choices of dimensions that are within the maximum permissible velocity.

Design of Trapezoidal Grass-Lined Diversions

The peak runoff storm frequency to be used is shown in Table 6-4.1. The design procedure, as described above for parabolic grass-lined diversions, is used with Tables 6-4.5 and 6-4.6.

Cross Section

The channel portion of the diversion may be parabolic or trapezoidal. The compacted ridge shall be designed to have stable side slopes, which will not be steeper than 2:1. The ridge shall be minimum width of four feet at the design water elevation after settlement. Ten percent shall be allowed for settlement.

Table 6-4.1 Diversion Design Criteria

Diversion Type	Land or Improvement Protected	Storm[1] Frequency	Freeboard	Minimum Top Width
Temporary	Construction areas Building sites	10 years	0.3'	4 feet
Permanent	Landscaped, recreation and similar areas.	25 years	0.3'	4 feet
	Dwellings, schools, commercial bldgs., and similar installations.	50 years	0.5'	4 feet

[1] Use 24-hour storm duration

Outlets

Each diversion must have an adequate outlet. The outlet may be a constructed or natural waterway, a stabilized vegetated area or a stabilized open channel. In all cases, the outlet must discharge in such a manner as not to cause an erosion problem. Protected outlets shall be constructed and stabilized prior to construction of the diversion.

Stabilization

Channels shall be stabilized in accordance with Item 5 of the construction specifications.

Roads and Utility Rights-of-Way

Diversions installed to divert water off a road or right-of-way shall consist of a series of compacted ridges of soil running diagonally across the road at a 30° angle. Ridges are constructed by excavating a channel upstream for this type of diversion.

A detailed design is not required for this type of diversion. The compacted ridge height shall be 8-12" above the original road surface; the channel depth shall be 8-12" below the original road surface. Channel bottoms and ridge tops shall be smooth enough to be crossed by vehicular traffic. The maximum spacing between diversions shall be as follows:

Road Grade (Percent)	Distance Between Diversions (Feet)
1	400
2	250
5	125
10	80
15	60
20	50

Stable outlets shall be provided for each diversion.

CONSTRUCTION SPECIFICATIONS

1. All trees, brush, stumps, obstructions, and other objectionable material shall be removed and disposed of so as not to interfere with the proper functioning of the diversion.
2. The diversion shall be excavated or shaped to line, grade, and cross section as required to meet the criteria specified herein and free of irregularities which will impede normal flow.
3. All fills shall be machine compacted as needed to prevent unequal settlement that would cause damage in the completed diversion.
4. All earth removed and not needed in construction shall be spread or disposed of so that it will not interfere with the functioning of the diversion.
5. Stabilization
   a. Vegetative Protection
      i. Follow the appropriate standard and specification of this manual for disturbed area stabilization for time of seeding, sprigging or sodding, liming and fertilizing, and site and seedbed preparation.
      ii. Mulching shall be a requirement for all seeded or sprigged channels and shall be performed at rates shown in Standard and Specification *Ds1-Disturbed Area Stabilization (With Mulching Only).*
      iii. Temporary protection during establishment should be provided when conditions permit the use of temporary diversions or other means to dispose of water.
   b. Mechanical Vegetative Protection
      Stone center diversions shall be stabilized with riprap in accordance with the *Riprap* section of Appendix C.
   c. Mechanical Protection
      Paving shall be performed in accordance with the Georgia Department of Transportation specifications for paved ditches.

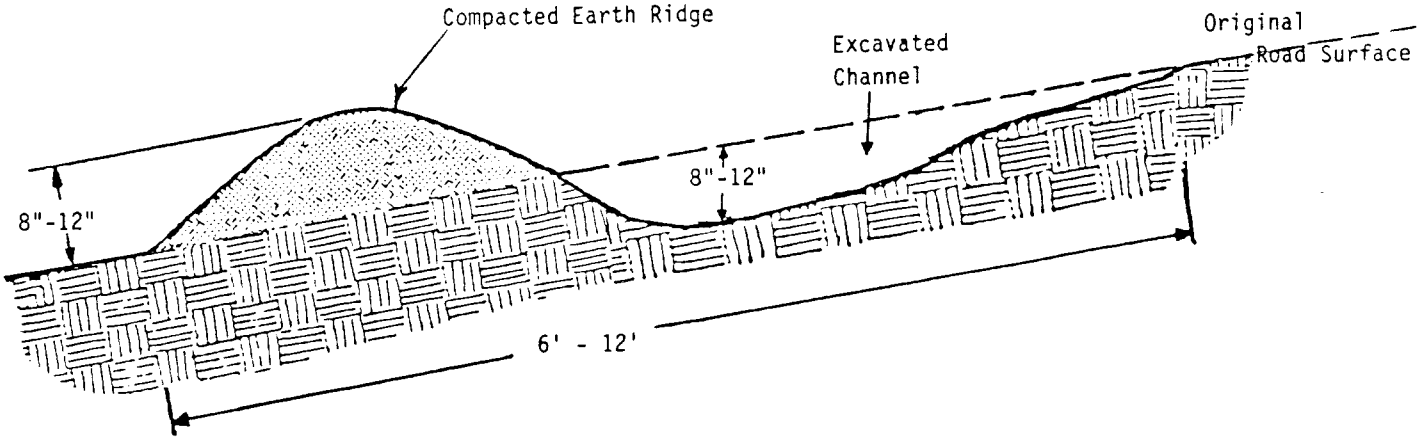


Figure 6-4.1 — Typical Diversion Across Road

VEGETATIVE COVER TYPE	GOOD STAND				MAXIMUM PERMISSIBLE VELOCITY, V_1, FEET PER SECOND
	FOR CAPACITY AND V_2		FOR STABILITY AND V_1		
	RETARDANCE	PLANT HT. NOT MOWED	RETARDANCE	PLANT HT. MOWED	
BERMUDAGRASS	B	12"	D	2-6"	5
BAHIA	C	6-12"	D	2-6"	4
TALL FESCUE GRASS MIXTURES[1]	B	18"	D	6"	4
SERICEA LESPEDEZA WEEPING LOVEGRASS	B	19"	D	2-6"	3
STONE CENTER	RIPRAP STONE SIZE CAN BE DETERMINED IN APPENDIX C.				

Permissible Velocities and Retardances for Vegetated and Rock-Lined Waterways

Table 6-4.2

[1]mixtures of Tall Fescue, Bahia, and/or Bermuda

NOTE: For planting instructions, refer to Disturbed Area Stabilization (With Permanent Vegetation) Ds3, page 6-167.

Diversions should be tailored to fit the conditions of a particular field and local soil type(s). The velocities should be kept as high as will be safe for the planned type of cover and the expected maintenance. Table 6-4.2 may be used as a guide in selecting design velocities.

Size of Channel

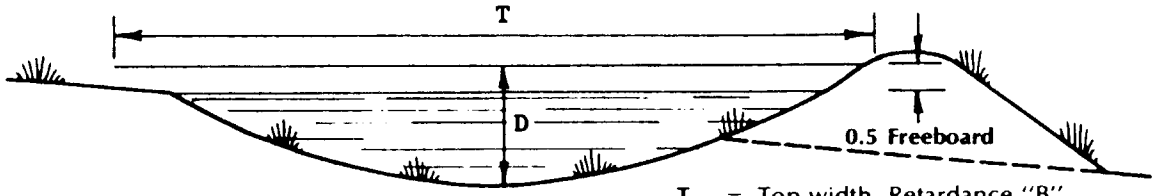
After "Q" and the safe velocity have been determined, the required size of diversion channel can be determined from Table 6-4.3 and 6-4.6, depending on the shape of channel desired.

Land slope must be taken into consideration when choosing channel dimensions. On the steeper slopes, narrow and deep channels may be required. On the more gentle slopes, broad, shallow channels usually are applicable. The wide, shallow section will be easier to maintain.

V_1 Based on Permissible Velocity of the Soil With Retardance "D"

Top Width, Depth & V_2 Based on Retardance "B" Grade = 0.25%

Q	V_1 = 2.0	V_1 = 2.5	V_1 = 3.0	V_1 = 3.5	V_1 = 4.0	V_1 = 4.5	V_1 = 5.0	V_1 = 5.5	V_1 = 6.0
cfs	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2
15									
20									
25	12 3.8 1.0								
30	14 3.6 1.1								
35	17 3.5 1.1								
40	19 3.5 1.2	13 4.1 1.4							
45	21 3.4 1.2	14 4.0 1.4							
50	23 3.4 1.2	16 3.9 1.5							
55	26 3.4 1.2	17 3.9 1.5							
60	28 3.4 1.2	19 3.9 1.5							
65	30 3.4 1.2	20 3.8 1.6							
70	32 3.4 1.2	22 3.8 1.6	15 4.5 1.8						
75	34 3.4 1.2	23 3.8 1.6	16 4.4 1.9						
80	37 3.4 1.2	25 3.8 1.6	17 4.4 1.9						
90	41 3.4 1.2	28 3.8 1.6	19 4.3 1.9						
100	46 3.4 1.2	31 3.7 1.6	21 4.3 2.0						
110	50 3.4 1.2	34 3.7 1.6	23 4.2 2.0						
120	55 3.4 1.3	37 3.7 1.6	26 4.2 2.0	18 5.0 2.3					
130	59 3.4 1.3	40 3.7 1.6	28 4.2 2.0	19 4.9 2.4					
140	64 3.3 1.3	43 3.7 1.7	30 4.2 2.0	21 4.9 2.4					
150	68 3.3 1.3	46 3.7 1.7	32 4.2 2.0	22 4.8 2.5					
160	73 3.3 1.3	49 3.7 1.7	34 4.2.2.0	24 4.8 2.5					
170	77 3.3 1.3	52 3.7 1.7	36 4.2 2.1	25 4.8 2.5	20 5.5 2.8				
180	82 3.3 1.3	55 3.7 1.7	38 4.2 2.1	26 4.7 2.6	21 5.4 2.8				
190	86 3.3 1.3	58 3.7 1.7	40 4.2 2.1	28 4.7 2.6	22 5.4 2.8				
200	91 3.3 1.3	61 3.7 1.7	42 4.2 2.1	29 4.7 2.6	23 5.3 2.9				
220		67 3.7 1.7	46 4.2 2.1	32 4.7 2.6	25 5.3 2.9				
240		73 3.7 1.7	50 4.1 2.1	35 4.7 2.6	27 5.2 3.0				
260		79 3.7 1.7	54 4.1 2.1	38 4.7 2.6	29 5.2 3.0	22 6.0 3.3			
280		85 3.7 1.7	59 4.1 2.1	40 4.6 2.6	31 5.1 3.1	24 5.9 3.4			
300		91 3.7 1.7	63 4.1 2.1	43 4.6 2.7	33 5.1 3.1	26 5.9 3.4			



T = Top width, Retardance "B"
D = Depth, Retardance "B"
V_2 = Velocity, Retardance "B"
V_1 = Velocity, Retardance "D"

(Settlement to be added to top of ridge.)

Table 6-4.3 - Parabolic diversion design chart (Sheet 1 of 6)

V_1 Based on Permissible Velocity of the Soil With Retardance "D"

Top Width, Depth & V_2 Based on Retardance "B" Grade = 0.5%

Q	V_1 = 2.0	V_1 = 2.5	V_1 = 3.0	V_1 = 3.5	V_1 = 4.0	V_1 = 4.5	V_1 = 5.0	V_1 = 5.5	V_1 = 6.0
cfs	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2
15	12 2.8 1.0								
20	15 2.7 1.0								
25	18 2.7 1.1	12 3.1 1.4							
30	22 2.6 1.1	14 3.0 1.4	10 3.4 1.6						
35	25 2.6 1.1	16 3.0 1.5	12 3.3 1.7						
40	29 2.6 1.1	18 2.9 1.5	13 3.2 1.8						
45	33 2.6 1.1	20 2.9 1.5	15 3.2 1.8						
50	36 2.6 1.1	22 2.9 1.5	17 3.1 1.9	12 3.7 2.1					
55	40 2.6 1.1	24 2.9 1.6	18 3.1 1.9	13 3.6 2.2					
60	43 2.6 1.1	27 2.9 1.6	20 3.1 1.9	14 3.6 2.2					
65	47 2.6 1.1	29 2.9 1.6	21 3.1 1.9	15 3.5 2.3					
70	50 2.6 1.1	31 2.9 1.6	23 3.1 1.9	16 3.5 2.3					
75	54 2.6 1.1	33 2.9 1.6	25 3.1 1.9	17 3.5 2.3	14 4.0 2.5				
80	58 2.6 1.1	35 2.9 1.6	26 3.1 1.9	18 3.5 2.4	15 3.9 2.6				
90	65 2.6 1.1	40 2.9 1.6	29 3.1 2.0	21 3.5 2.4	16 3.9 2.6				
100	72 2.6 1.1	44 2.8 1.6	32 3.1 2.0	23 3.4 2.4	18 3.8 2.7	14 4.3 3.0			
110	79 2.6 1.1	48 2.8 1.6	36 3.1 2.0	25 3.4 2.4	20 3.8 2.8	16 4.2 3.1			
120	86 2.6 1.1	52 2.8 1.6	39 3.1 2.0	27 3.4 2.5	21 3.7 2.8	17 4.1 3.1			
130	93 2.6 1.1	57 2.8 1.6	42 3.1 2.0	30 3.4 2.5	23 3.7 2.8	18 4.1 3.2			
140		61 2.8 1.6	45 3.1 2.0	32 3.4 2.5	25 3.7 2.8	19 4.1 3.2			
150		65 2.8 1.6	48 3.1 2.0	34 3.4 2.5	26 3.7 2.9	21 4.1 3.2	17 4.6 3.5		
160		70 2.8 1.6	52 3.0 2.0	36 3.4 2.5	28 3.7 2.9	22 4.0 3.3	18 4.5 3.6		
170		74 2.8 1.6	55 3.0 2.0	39 3.4 2.5	30 3.7 2.9	24 4.0 3.3	19 4.5 3.6		
180		78 2.8 1.6	58 3.0 2.0	41 3.4 2.5	31 3.7 2.9	25 4.0 3.3	20 4.5 3.7		
190		83 2.8 1.6	61 3.0 2.0	43 3.4 2.5	33 3.7 2.9	26 4.0 3.3	21 4.5 3.7		
200		87 2.8 1.6	64 3.0 2.0	45 3.4 2.5	35 3.7 2.9	27 4.0 3.3	22 4.4 3.8	18 5.0 4.0	
220		95 2.8 1.6	71 3.0 2.0	50 3.4 2.5	38 3.7 2.9	30 4.0 3.4	24 4.4 3.8	19 4.9 4.1	
240			77 3.0 2.0	54 3.4 2.5	42 3.7 2.9	33 4.0 3.4	26 4.4 3.8	21 4.9 4.1	
260			83 3.0 2.0	59 3.4 2.5	45 3.7 3.0	36 4.0 3.4	28 4.3 3.9	23 4.8 4.2	
280			90 3.0 2.0	63 3.4 2.5	48 3.7 3.0	38 4.0 3.4	30 4.3 3.9	24 4.8 4.2	20 5.4 4.5
300			96 3.0 2.0	68 3.4 2.5	52 3.6 3.0	41 4.0 3.4	32 4.3 3.9	26 4.8 4.3	21 5.3 4.6

T = Top width, Retardance "B"
D = Depth, Retardance "B"
V_2 = Velocity, Retardance "B"
V_1 = Velocity, Retardance "D"

Table 6-4.3 - Parabolic diversion design chart (Sheet 2 of 6)

V_1 Based on Permissible Velocity of the Soil With Retardance "D"

Top Width, Depth & V_2 Based on Retardance "B" Grade = 0.75%

Q	V_1 = 2.0	V_1 = 2.5	V_1 = 3.0	V_1 = 3.5	V_1 = 4.0	V_1 = 4.5	V_1 = 5.0	V_1 = 5.5	V_1 = 6.0
cfs	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2
15	16 2.3 0.9	10 2.7 1.2							
20	21 2.3 0.9	12 2.6 1.4							
25	26 2.2 1.0	14 2.5 1.4	11 2.8 1.7						
30	31 2.2 1.0	17 2.5 1.4	12 2.8 1.8	10 3.1 1.9					
35	36 2.2 1.0	20 2.5 1.5	14 2.7 1.8	11 3.0 2.1					
40	41 2.2 1.0	23 2.5 1.5	16 2.7 1.8	13 2.9 2.1					
45	46 2.2 1.0	26 2.5 1.5	18 2.7 1.9	14 2.9 2.2					
50	51 2.2 1.0	28 2.5 1.5	20 2.7 1.9	16 2.9 2.2	12 3.3 2.5				
55	56 2.2 1.0	31 2.5 1.5	22 2.7 1.9	17 2.9 2.2	13 3.3 2.5				
60	61 2.2 1.0	34 2.5 1.5	24 2.7 1.9	19 2.9 2.2	14 3.2 2.6				
65	66 2.2 1.0	37 2.5 1.5	26 2.6 1.9	20 2.8 2.3	15 3.2 2.6	12 3.5 2.8			
70	71 2.2 1.0	39 2.5 1.5	28 2.6 1.9	22 2.8 2.3	16 3.2 2.7	13 3.5 2.9			
75	76 2.2 1.0	42 2.5 1.5	30 2.6 1.9	23 2.8 2.3	17 3.2 2.7	14 3.5 2.9			
80	81 2.2 1.0	45 2.5 1.5	32 2.6 1.9	25 2.8 2.3	18 3.2 2.7	15 3.4 3.0			
90	91 2.2 1.0	50 2.5 1.5	36 2.6 1.9	28 2.8 2.3	20 3.1 2.8	16 3.4 3.1	13 3.8 3.3		
100		56 2.5 1.5	40 2.6 1.9	31 2.8 2.3	22 3.1 2.8	18 3.4 3.1	15 3.7 3.4		
110		61 2.5 1.5	44 2.6 1.9	34 2.8 2.3	25 3.1 2.8	20 3.3 3.2	16 3.7 3.5		
120		67 2.5 1.5	48 2.6 2.0	37 2.8 2.3	27 3.1 2.8	22 3.3 3.2	18 3.6 3.5	14 4.0 3.8	
130		72 2.5 1.5	52 2.6 2.0	40 2.8 2.3	29 3.1 2.9	23 3.3 3.2	19 3.6 3.6	16 4.0 3.8	
140		78 2.5 1.5	56 2.6 2.0	43 2.8 2.3	31 3.1 2.9	25 3.3 3.2	20 3.6 3.6	17 4.0 3.9	
150		83 2.5 1.6	60 2.6 2.0	46 2.8 2.3	33 3.1 2.9	27 3.3 3.2	22 3.6 3.7	18 3.9 4.0	
160		89 2.5 1.6	64 2.6 2.0	49 2.8 2.3	35 3.1 2.9	29 3.3 3.3	23 3.6 3.7	19 3.9 4.0	15 4.3 4.4
170		94 2.5 1.6	68 2.6 2.0	52 2.8 2.3	38 3.1 2.9	31 3.3 3.3	24 3.5 3.7	20 3.9 4.1	16 4.3 4.4
180			72 2.6 2.0	55 2.8 2.3	40 3.1 2.9	32 3.3 3.3	26 3.5 3.7	21 3.8 4.1	17 4.2 4.5
190			76 2.6 2.0	58 2.8 2.3	42 3.1 2.9	34 3.3 3.3	27 3.5 3.7	22 3.8 4.1	18 4.2 4.5
200			80 2.6 2.0	61 2.8 2.3	44 3.1 2.9	36 3.3 3.3	29 3.5 3.7	23 3.8 4.2	19 4.2 4.5
220			87 2.6 2.0	68 2.8 2.3	48 3.1 2.9	39 3.3 3.3	32 3.5 3.7	26 3.8 4.2	21 4.2 4.6
240			95 2.6 2.0	74 2.8 2.4	53 3.1 2.9	43 3.3 3.3	34 3.5 3.8	28 3.8 4.2	23 4.1 4.6
260				80 2.8 2.4	57 3.1 2.9	46 3.3 3.3	37 3.5 3.8	30 3.8 4.2	25 4.1 4.7
280				86 2.8 2.4	62 3.1 2.9	50 3.3 3.3	40 3.5 3.8	32 3.8 4.3	26 4.1 4.7
300				92 2.8 2.4	66 3.1 2.9	53 3.3 3.3	43 3.5 3.8	35 3.8 4.3	28 4.1 4.7

T = Top width, Retardance "B"
D = Depth, Retardance "B"
V_2 = Velocity, Retardance "B"
V_1 = Velocity, Retardance "D"

(Settlement to be added to top of ridge.)

Table 6-4.3 - Parabolic diversion design chart (Sheet 3 of 6)

V_1 Based on Permissible Velocity of the Soil With Retardance "D"

Top Width, Depth & V_2 Based on Retardance "B" Grade = 1.0%

Q	V_1 = 2.0	V_1 = 2.5	V_1 = 3.0	V_1 = 3.5	V_1 = 4.0	V_1 = 4.5	V_1 = 5.0	V_1 = 5.5	V_1 = 6.0
cfs	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2
15	18 2.1 0.9	11 2.3 1.2							
20	24 2.0 0.9	15 2.2 1.3	10 2.5 1.7						
25	30 2.0 0.9	19 2.2 1.3	12 2.5 1.7	10 2.7 1.9					
30	36 2.0 0.9	22 2.2 1.4	15 2.4 1.8	12 2.6 2.0					
35	42 2.0 0.9	26 2.2 1.4	17 2.4 1.8	14 2.6 2.1	10 2.9 2.4				
40	48 2.0 1.0	29 2.2 1.4	19 2.4 1.8	15 2.5 2.1	12 2.8 2.5				
45	54 2.0 1.0	33 2.2 1.4	22 2.4 1.8	17 2.5 2.1	13 2.8 2.5				
50	59 2.0 1.0	37 2.2 1.4	24 2.4 1.9	19 2.5 2.2	14 2.8 2.5	11 3.1 2.9			
55	65 2.0 1.0	40 2.2 1.4	26 2.4 1.9	21 2.5 2.2	16 2.8 2.6	12 3.1 2.9			
60	71 2.0 1.0	44 2.2 1.4	29 2.4 1.9	23 2.5 2.2	17 2.7 2.6	13 3.0 3.0			
65	77 2.0 1.0	47 2.2 1.4	31 2.4 1.9	25 2.5 2.2	18 2.7 2.6	14 3.0 3.0	11 3.4 3.2		
70	83 2.0 1.0	51 2.2 1.4	33 2.4 1.9	26 2.5 2.2	20 2.7 2.6	15 3.0 3.0	12 3.3 3.3		
75	88 2.0 1.0	54 2.2 1.4	36 2.4 1.9	28 2.5 2.2	21 2.7 2.7	16 3.0 3.1	13 3.3 3.4		
80	94 2.0 1.0	58 2.2 1.4	38 2.4 1.9	30 2.5 2.2	23 2.7 2.7	17 3.0 3.1	14 3.2 3.4		
90		65 2.2 1.4	43 2.4 1.9	34 2.5 2.2	25 2.7 2.7	19 3.0 3.1	16 3.2 3.5	13 3.5 3.8	
100		72 2.2 1.4	47 2.4 1.9	38 2.5 2.2	28 2.7 2.7	21 3.0 3.1	17 3.2 3.6	14 3.4 3.9	
110		79 2.2 1.4	52 2.4 1.9	41 2.5 2.3	31 2.7 2.7	23 2.9 3.2	19 3.2 3.6	16 3.4 3.9	13 3.7 4.1
120		86 2.2 1.4	57 2.4 1.9	45 2.5 2.3	34 2.7 2.7	25 2.9 3.2	21 3.2 3.6	17 3.4 4.0	15 3.7 4.2
130		94 2.2 1.4	61 2.4 1.9	49 2.5 2.3	36 2.7 2.7	27 2.9 3.2	22 3.1 3.6	18 3.4 4.0	16 3.6 4.3
140			66 2.4 1.9	52 2.5 2.3	39 2.7 2.7	29 2.9 3.2	23 3.1 3.6	20 3.4 4.1	17 3.6 4.3
150			71 2.4 1.9	56 2.5 2.3	42 2.7 2.7	31 2.9 3.2	26 3.1 3.7	21 3.4 4.1	18 3.6 4.4
160			75 2.4 1.9	60 2.5 2.3	45 2.7 2.7	33 2.9 3.2	27 3.1 3.7	22 3.4 4.1	19 3.6 4.4
170			80 2.4 1.9	63 2.5 2.3	47 2.7 2.7	35 2.9 3.3	29 3.1 3.7	24 3.4 4.1	20 3.6 4.5
180			84 2.4 1.9	67 2.5 2.3	50 2.7 2.7	38 2.9 3.3	31 3.1 3.7	25 3.3 4.1	21 3.5 4.5
190			89 2.4 1.9	71 2.5 2.3	53 2.7 2.7	40 2.9 3.3	32 3.1 3.7	26 3.3 4.2	22 3.5 4.5
200			94 2.4 1.9	74 2.5 2.3	55 2.7 2.7	42 2.9 3.3	34 3.1 3.7	28 3.3 4.2	24 3.5 4.6
220				82 2.5 2.3	61 2.7 2.7	46 2.9 3.3	37 3.1 3.7	30 3.3 4.2	26 3.5 4.6
240				89 2.5 2.3	66 2.7 2.8	50 2.9 3.3	41 3.1 3.7	33 3.3 4.2	28 3.5 4.6
260				96 2.5 2.3	72 2.7 2.8	54 2.9 3.3	44 3.1 3.8	36 3.3 4.2	30 3.5 4.7
280					77 2.7 2.8	58 2.9 3.3	47 3.1 3.8	38 3.3 4.2	33 3.5 4.7
300					83 2.7 2.8	62 2.9 3.3	50 3.1 3.8	41 3.3 4.2	35 3.5 4.7

T = Top width, Retardance "B"
D = Depth, Retardance "B"
V_2 = Velocity, Retardance "B"
V_1 = Velocity, Retardance "D"

(Settlement to be added to top of ridge.)

Table 6-4.3 - Parabolic diversion design chart (Sheet 4 of 6)

V_1 Based on Permissible Velocity of the Soil With Retardance "D"

Top Width, Depth & V_2 Based on Retardance "B" Grade = 1.5%

Q	V_1 = 2.0	V_1 = 2.5	V_1 = 3.0	V_1 = 3.5	V_1 = 4.0	V_1 = 4.5	V_1 = 5.0	V_1 = 5.5	V_1 = 6.0
cfs	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2
15	24 1.8 0.9	15 1.9 1.2	10 2.2 1.5						
20	32 1.8 0.9	20 1.9 1.2	14 2.1 1.6						
25	39 1.8 0.9	25 1.9 1.2	17 2.1 1.6	11 2.3 2.1					
30	47 1.8 0.9	31 1.9 1.2	20 2.1 1.6	13 2.3 2.2	11 2.4 2.4				
35	55 1.8 0.9	36 1.9 1.2	23 2.1 1.7	16 2.2 2.2	13 2.4 2.5	10 2.6 2.7			
40	63 1.8 0.9	41 1.9 1.2	27 2.1 1.7	18 2.2 2.2	14 2.3 2.6	12 2.5 2.8			
45	70 1.8 0.9	46 1.9 1.2	30 2.1 1.7	20 2.2 2.2	16 2.3 2.6	13 2.5 2.8	10 2.8 3.2		
50	78 1.8 0.9	51 1.9 1.2	33 2.1 1.7	22 2.2 2.2	18 2.3 2.6	15 2.5 2.9	11 2.8 3.3		
55	86 1.8 0.9	55 1.9 1.2	36 2.1 1.7	24 2.2 2.3	20 2.3 2.6	16 2.5 2.9	12 2.7 3.4	10 3.0 3.5	
60	93 1.8 0.9	60 1.9 1.2	40 2.0 1.7	26 2.2 2.3	21 2.3 2.6	17 2.5 2.9	13 2.7 3.4	11 3.0 3.6	
65		65 1.9 1.2	43 2.0 1.7	29 2.2 2.3	23 2.3 2.6	19 2.5 3.0	14 2.7 3.4	12 2.9 3.7	
70		70 1.9 1.2	46 2.0 1.7	31 2.2 2.3	25 2.3 2.6	20 2.5 3.0	15 2.7 3.4	13 2.9 3.8	11 3.1 4.0
75		75 1.9 1.2	49 2.0 1.7	33 2.2 2.3	26 2.3 2.7	22 2.5 3.0	16 2.7 3.5	14 2.9 3.8	12 3.1.4.0
80		80 1.9 1.2	52 2.0 1.7	35 2.2 2.3	28 2.3 2.7	23 2.5 3.0	18 2.7 3.5	15 2.9 3.8	13 3.1 4.2
90		90 1.9 1.2	59 2.0 1.7	39 2.2 2.3	32 2.3 2.7	26 2.5 3.0	20 2.7 3.5	16 2.8 3.9	14 3.0 4.2
100			65 2.0 1.7	44 2.2 2.3	35 2.3 2.7	29 2.4 3.0	22 2.7 3.5	18 2.8 4.0	15 3.0 4.3
110			72 2.0 1.7	48 2.2 2.3	39 2.3 2.7	31 2.4 3.0	24 2.7 3.5	20 2.8 4.0	17 3.0 4.4
120			78 2.0 1.7	52 2.2 2.3	42 2.3 2.7	34 2.4 3.0	26 2.6 3.6	22 2.8 4.0	18 3.0 4.4
130			85 2.0 1.7	57 2.2 2.3	45 2.3 2.7	37 2.4 3.0	28 2.6 3.6	23 2.8 4.0	19 3.0 4.4
140			91 2.0 1.7	61 2.2 2.3	49 2.3 2.7	40 2.4 3.1	30 2.6 3.6	25 2.8 4.0	21 3.0 4.5
150			97 2.0 1.7	65 2.2 2.3	52 2.3 2.7	43 2.4 3.1	32 2.6 3.6	27 2.8 4.0	22 2.9 4.5
160				69 2.2 2.3	56 2.3 2.7	45 2.4 3.1	34 2.6 3.6	29 2.8 4.1	24 2.9 4.5
170				74 2.2 2.3	59 2.3 2.7	48 2.4 3.1	37 2.6 3.6	30 2.8 4.1	25 2.9 4.5
180				78 2.2 2.3	63 2.3 2.7	51 2.4 3.1	39 2.6 3.6	32 2.8 4.1	27 2.9 4.6
190	T = Top width, Retardance "B"			82 2.2 2.3	66 2.3 2.7	54 2.4 3.1	41 2.6 3.7	34 2.8 4.1	28 2.9 4.6
200	D = Depth, Retardance "B"			86 2.2 2.3	69 2.3 2.7	56 2.4 3.1	43 2.6 3.7	36 2.8 4.1	30 2.9 4.6
220	V_2 = Velocity, Retardance "B"			95 2.2 2.3	76 2.3 2.7	62 2.4 3.1	47 2.6 3.7	39 2.8 4.1	33 2.9 4.6
240	V_1 = Velocity, Retardance "D"				83 2.3 2.7	68 2.4 3.1	51 2.6 3.7	43 2.8 4.1	35 2.9 4.6
260					90 2.3 2.7	73 2.4 3.1	55 2.6 3.7	46 2.8 4.1	38 2.9 4.6
280	(Settlement to be added to top of ridge.)				97 2.3 2.7	79 2.4 3.1	60 2.6 3.7	50 2.8 4.1	41 2.9 4.6
300						84 2.4 3.1	64 2.6 3.7	53 2.8 4.1	44 2.9 4.7

Table 6-4.3 - Parabolic diversion design chart (Sheet 5 of 6)

V_1 Based on Permissible Velocity of the Soil With Retardance "D"

Top Width, Depth & V_2 Based on Retardance "B" Grade = 2.0%

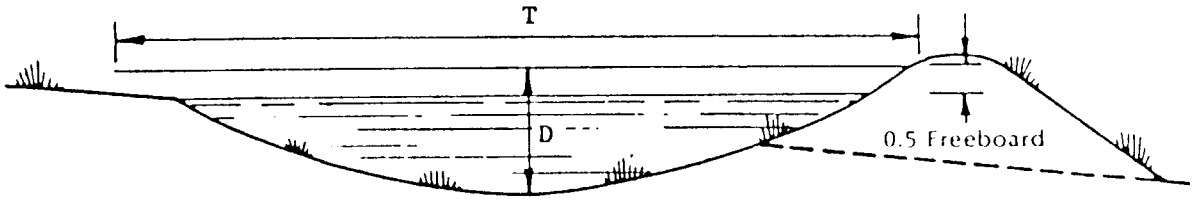
Q	V_1 = 2.0	V_1 = 2.5	V_1 = 3.0	V_1 = 3.5	V_1 = 4.0	V_1 = 4.5	V_1 = 5.0	V_1 = 5.5	V_1 = 6.0
cfs	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2
15	30 1.6 0.8	18 1.8 1.2	13 1.9 1.4	9 2.1 1.8					
20	39 1.6 0.8	24 1.8 1.2	17 1.9 1.5	12 2.0 1.9					
25	49 1.6 0.8	30 1.7 1.2	21 1.9 1.5	15 2.0 2.0	11 2.2 2.4				
30	59 1.6 0.8	35 1.7 1.2	25 1.9 1.5	18 2.0 2.0	13 2.1 2.5	10 2.3 2.8			
35	68 1.6 0.8	41 1.7 1.2	29 1.9 1.5	21 2.0 2.0	15 2.1 2.5	12 2.2 2.9	10 2.4 3.0		
40	78 1.6 0.8	47 1.7 1.2	34 1.9 1.5	23 2.0 2.0	17 2.1 2.5	14 2.2 2.9	11 2.4 3.2		
45	88 1.6 0.8	53 1.7 1.2	38 1.9 1.5	26 2.0 2.0	19 2.1 2.5	15 2.2 2.9	13 2.4 3.2	10 2.6 3.5	
50	97 1.6 0.8	59 1.7 1.2	42 1.9 1.6	29 2.0 2.0	21 2.1 2.6	17 2.2 2.9	14 2.4 3.2	11 2.5 3.6	
55		64 1.7 1.2	46 1.8 1.6	32 2.0 2.0	23 2.1 2.6	19 2.2 2.9	15 2.4 3.3	12 2.5 3.7	10 2.7 4.0
60		70 1.7 1.2	50 1.8 1.6	35 2.0 2.0	25 2.1 2.6	20 2.2 3.0	17 2.4 3.3	13 2.5 3.7	11 2.7 4.0
65		76 1.7 1.2	54 1.8 1.6	38 2.0 2.0	27 2.1 2.6	22 2.2 3.0	18 2.3 3.4	15 2.5 3.7	12 2.7 4.1
70		81 1.7 1.2	58 1.8 1.6	41 2.0 2.1	29 2.1 2.6	24 2.2 3.0	19 2.3 3.4	16 2.5 3.8	13 2.7 4.1
75		87 1.7 1.2	62 1.8 1.6	43 2.0 2.1	31 2.1 2.6	25 2.2 3.0	21 2.3 3.4	17 2.5 3.8	14 2.7 4.1
80		93 1.7 1.2	68 1.8 1.6	46 2.0 2.1	33 2.1 2.6	27 2.2 3.0	22 2.3 3.4	18 2.5 3.8	15 2.6 4.2
90			74 1.8 1.6	52 2.0 2.1	37 2.1 2.6	30 2.2 3.0	25 2.3 3.4	20 2.5 3.8	17 2.6 4.2
100			83 1.8 1.6	58 2.0 2.1	41 2.1 2.6	34 2.2 3.0	27 2.3 3.4	22 2.5 3.9	18 2.6 4.3
110			91 1.8 1.6	63 2.0 2.1	45 2.1 2.6	37 2.2 3.0	30 2.3 3.4	24 2.5 3.9	20 2.6 4.3
120			99 1.8 1.6	69 2.0 2.1	49 2.1 2.6	40 2.2 3.0	33 2.3 3.4	26 2.4 3.9	22 2.6 4.3
130				75 2.0 2.1	53 2.1 2.6	44 2.2 3.0	35 2.3 3.4	29 2.4 3.9	24 2.6 4.3
140				80 2.0 2.1	57 2.1 2.6	47 2.2 3.0	38 2.3 3.5	31 2.4 3.9	26 2.6 4.4
150				86 2.0 2.1	61 2.1 2.7	50 2.2 3.0	41 2.3 3.5	33 2.4 3.9	27 2.6 4.4
160				91 2.0 2.1	65 2.1 2.7	53 2.2 3.0	43 2.3 3.5	35 2.4 3.9	29 2.6 4.4
170				97 2.0 2.1	69 2.1 2.7	57 2.2 3.1	46 2.3 3.5	37 2.4 4.0	31 2.6 4.4
180	T = Top width, Retardance "B"				73 2.1 2.7	60 2.2 3.1	49 2.3 3.5	39 2.4 4.0	33 2.6 4.4
190	D = Depth, Retardance "B"				77 2.1 2.7	63 2.2 3.1	51 2.3 3.5	41 2.4 4.0	34 2.6 4.5
200	V_2 = Velocity, Retardance "B"				81 2.1 2.7	66 2.2 3.1	54 2.3 3.5	44 2.4 4.0	36 2.6 4.5
220	V_1 = Velocity, Retardance "D"				89 2.1 2.7	73 2.2 3.1	59 2.3 3.5	48 2.4 4.0	40 2.6 4.5
240					97 2.1 2.7	79 2.2 3.1	65 2.3 3.5	52 2.4 4.0	43 2.6 4.5
260	(Settlement to be added to top of ridge.)					86 2.2 3.1	70 2.3 3.5	56 2.4 4.0	47 2.6 4.5
280						92 2.2 3.1	75 2.3 3.5	61 2.4 4.0	50 2.6 4.5
300						99 2.2 3.1	81 2.3 3.5	65 2.4 4.0	54 2.6 4.5

Table 6-4.3 - Parabolic diversion design chart (Sheet 6 of 6)

V_1 Based on Permissible Velocity of the Soil With Retardance "D"

Top Width, Depth & V_2 Based on Retardance "C" Grade = 0.25%

Q	V_1 = 2.0	V_1 = 2.5	V_1 = 3.0	V_1 = 3.5	V_1 = 4.0	V_1 = 4.5	V_1 = 5.0	V_1 = 5.5	V_1 = 6.0
cfs	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2
15									
20									
25	11 2.9 1.6								
30	13 2.8 1.7								
35	15 2.8 1.7								
40	17 2.8 1.8	11 3.2 2.1							
45	19 2.7 1.8	13 3.1 2.2							
50	21 2.7 1.8	14 3.1 2.2							
55	23 2.7 1.8	15 3.1 2.3							
60	25 2.7 1.8	17 3.0 2.3							
65	27 2.7 1.8	18 3.0 2.3							
70	29 2.7 1.9	19 3.0 2.3	14 3.6 2.7						
75	31 2.7 1.9	21 3.0 2.3	15 3.5 2.8						
80	33 2.7 1.9	22 3.0 2.4	16 3.5 2.8						
90	37 2.7 1.9	25 3.0 2.4	17 3.5 2.8						
100	41 2.7 1.9	28 3.0 2.4	19 3.5 2.9						
110	45 2.7 1.9	30 3.0 2.4	21 3.4 2.9						
120	49 2.7 1.9	33 3.0 2.4	23 3.4 2.9	16 4.1 3.3					
130	53 2.7 1.9	36 3.0 2.4	25 3.4 2.9	18 4.1 3.3					
140	57 2.7 1.9	38 3.0 2.4	27 3.4 2.9	19 4.0 3.4					
150	61 2.7 1.9	41 3.0 2.4	29 3.4 2.9	20 4.0 3.4					
160	65 2.7 1.9	44 3.0 2.4	30 3.4 3.0	21 4.0 3.4					
170	69 2.7 1.9	46 3.0 2.4	32 3.4 3.0	23 4.0 3.4	18 4.5 3.8				
180	73 2.7 1.9	49 3.0 2.4	34 3.4 3.0	24 4.0 3.5	19 4.5 3.8				
190	77 2.7 1.9	52 3.0 2.4	36 3.4 3.0	25 4.0 3.5	20 4.5 3.9				
200	81 2.7 1.9	55 3.0 2.4	38 3.4 3.0	27 3.9 3.5	21 4.4 3.9				
220	89 2.7 1.9	60 3.0 2.4	42 3.4 3.0	29 3.9 3.5	23 4.4 3.9				
240	97 2.7 1.9	65 3.0 2.5	45 3.4 3.0	32 3.9 3.6	25 4.4 4.0				
260		71 3.0 2.5	49 3.4 3.0	34 3.9 3.6	27 4.4 4.0	21 5.1 4.3			
280		76 3.0 2.5	53 3.4 3.0	37 3.9 3.6	29 4.4 4.0	22 5.1 4.3			
300		82 3.0 2.5	57 3.4 3.0	40 3.9 3.6	31 4.3 4.1	24 5.0 4.4			



T = Top width, Retardance "C"
D = Depth, Retardance "C"
V_2 = Velocity, Retardance "C"
V_1 = Velocity, Retardance "D"

(Settlement to be added to top of ridge.)

Table 6-4.4 - Parabolic diversion design chart (Sheet 1 of 6)

V_1 Based on Permissible Velocity of the Soil With Retardance "D"

Top Width, Depth & V_2 Based on Retardance "C" Grade = 0.5%

Q	V_1 = 2.0	V_1 = 2.5	V_1 = 3.0	V_1 = 3.5	V_1 = 4.0	V_1 = 4.5	V_1 = 5.0	V_1 = 5.5	V_1 = 6.0
cfs	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2
15	10 2.1 1.6								
20	13 2.1 1.7								
25	16 2.1 1.7	10 2.4 2.1							
30	20 2.1 1.7	12 2.4 2.2	9 2.7 2.5						
35	23 2.1 1.7	14 2.4 2.3	11 2.6 2.6						
40	26 2.1 1.7	16 2.3 2.3	12 2.6 2.7						
45	29 2.0 1.7	18 2.3 2.3	13 2.5 2.8						
50	32 2.0 1.7	20 2.3 2.4	15 2.5 2.8	11 2.9 3.2					
55	35 2.0 1.7	22 2.3 2.4	16 2.5 2.8	12 2.9 3.3					
60	39 2.0 1.7	24 2.3 2.4	18 2.5 2.8	13 2.9 3.3					
65	42 2.0 1.8	26 2.3 2.4	19 2.5 2.9	14 2.9 3.3					
70	45 2.0 1.8	28 2.3 2.4	21 2.5 2.9	15 2.8 3.4					
75	48 2.0 1.8	30 2.3 2.4	22 2.5 2.9	16 2.8 3.4	12 3.2 3.7				
80	51 2.0 1.8	32 2.3 2.4	23 2.5 2.9	17 2.8 3.4	13 3.2 3.8				
90	57 2.0 1.8	35 2.3 2.4	26 2.5 2.9	19 2.8 3.4	15 3.2 3.8				
100	64 2.0 1.8	39 2.3 2.4	29 2.5 2.9	21 2.8 3.5	16 3.1 3.9	13 3.5 4.1			
110	70 2.0 1.8	43 2.3 2.4	32 2.5 2.9	23 2.8 3.5	18 3.1 3.9	14 3.5 4.2			
120	76 2.0 1.8	47 2.3 2.4	35 2.5 2.9	25 2.8 3.5	19 3.1 3.9	15 3.4 4.3			
130	83 2.0 1.8	51 2.3 2.4	38 2.5 2.9	27 2.8 3.5	21 3.1 4.0	17 3.4 4.4			
140	89 2.0 1.8	55 2.3 2.4	41 2.5 2.9	29 2.8 3.5	22 3.1 4.0	18 3.4 4.3			
150	95 2.0 1.8	59 2.3 2.4	44 2.5 2.9	31 2.8 3.5	24 3.1 4.0	19 3.4 4.4	15 3.8 4.8		
160		62 2.3 2.4	46 2.5 2.9	33 2.8 3.5	25 3.1 4.0	20 3.4 4.4	16 3.8 4.8		
170		66 2.3 2.4	49 2.5 2.9	35 2.8 3.6	27 3.1 4.0	22 3.4 4.4	17 3.8 4.9		
180		70 2.3 2.4	52 2.5 2.9	37 2.8 3.6	29 3.1 4.0	23 3.4 4.5	18 3.8 4.9		
190		74 2.3 2.4	55 2.5 2.9	39 2.8 3.6	30 3.1 4.0	24 3.4 4.5	19 3.8 5.0		
200		78 2.3 2.4	58 2.5 2.9	41 2.8 3.6	32 3.1 4.0	25 3.4 4.5	20 3.8 5.0	16 4.2 5.2	
220		86 2.3 2.4	64 2.5 2.9	45 2.8 3.6	35 3.1 4.0	28 3.4 4.5	22 3.7 5.0	18 4.2 5.3	
240		93 2.3 2.4	69 2.5 2.9	49 2.8 3.6	38 3.0 4.1	30 3.4 4.5	24 3.7 5.0	20 4.2 5.4	
260			75 2.5 2.9	53 2.8 3.6	41 3.0 4.1	33 3.4 4.5	26 3.7 5.0	21 4.1 5.4	
280			81 2.5 3.0	57 2.8 3.6	44 3.0 4.1	35 3.3 4.6	28 3.7 5.0	23 4.1 5.5	19 4.6 5.8
300			87 2.5 3.0	61 2.8 3.6	47 3.0 4.1	38 3.3 4.6	30 3.6 5.0	24 4.1 5.5	20 4.6 5.8

T = Top Width, Retardance "C"
D = Depth, Retardance "C"
V_2 = Velocity, Retardance "C"
V_1 = Velocity, Retardance "D"

(Settlement to be added to top of ridge.)

Table 6-4.4 - Parabolic diversion design chart (Sheet 2 of 6)

V_1 Based on Permissible Velocity of the Soil With Retardance "D"

Top Width, Depth & V_2 Based on Retardance "C" Grade = 0.75%

Q	V_1 = 2.0	V_1 = 2.5	V_1 = 3.0	V_1 = 3.5	V_1 = 4.0	V_1 = 4.5	V_1 = 5.0	V_1 = 5.5	V_1 = 6.0
cfs	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2
15	14 1.8 1.5								
20	18 1.8 1.5	10 2.0 2.2							
25	23 1.8 1.5	13 2.0 2.2							
30	27 1.8 1.5	15 2.0 2.2	11 2.2 2.7						
35	32 1.8 1.5	18 2.0 2.3	13 2.2 2.7	10 2.4 3.1					
40	37 1.8 1.5	20 2.0 2.3	15 2.2 2.8	11 2.4 3.2					
45	41 1.8 1.6	23 2.0 2.3	17 2.2 2.8	13 2.3 3.2					
50	45 1.8 1.6	25 2.0 2.3	18 2.1 2.9	14 2.3 3.3	10 2.7 3.7				
55	50 1.8 1.6	28 2.0 2.3	20 2.1 2.9	16 2.3 3.3	11 2.6 3.8				
60	54 1.8 1.6	30 2.0 2.3	22 2.1 2.9	17 2.3 3.3	12 2.6 3.8				
65	59 1.8 1.6	33 2.0 2.3	24 2.1 2.9	18 2.3 3.3	13 2.6 3.8	11 2.9 4.1			
70	63 1.8 1.6	35 2.0 2.3	25 2.1 2.9	20 2.3 3.3	14 2.6 3.9	12 2.9 4.2			
75	68 1.8 1.6	38 2.0 2.3	27 2.1 2.9	21 2.3 3.3	15 2.6 3.9	13 2.8 4.2			
80	72 1.8 1.6	40 2.0 2.3	29 2.1 2.9	23 2.3 3.3	16 2.6 3.9	14 2.8 4.3			
90	81 1.8 1.6	45 2.0 2.3	33 2.1 2.9	25 2.3 3.4	18 2.6 4.0	15 2.8 4.4	12 3.1 4.6		
100	90 1.8 1.6	50 2.0 2.3	36 2.1 2.9	28 2.3 3.4	20 2.6 4.0	17 2.8 4.4	13 3.1 4.8		
110	99 1.8 1.6	55 2.0 2.3	40 2.1 2.9	31 2.3 3.4	22 2.5 4.0	18 2.8 4.5	15 3.1 4.8		
120		60 2.0 2.3	43 2.1 2.9	34 2.3 3.4	24 2.5 4.0	20 2.8 4.5	16 3.0 4.8	13 3.4 5.2	
130		65 2.0 2.4	47 2.1 2.9	36 2.3 3.4	26 2.5 4.0	21 2.7 4.5	17 3.0 4.9	14 3.3 5.3	
140		70 2.0 2.4	50 2.1 2.9	39 2.3 3.4	28 2.5 4.1	23 2.7 4.5	19 3.0 4.9	15 3.3 5.3	
150		75 2.0 2.4	54 2.1 2.9	42 2.3 3.4	30 2.5 4.1	25 2.7 4.5	20 3.0 4.9	16 3.3 5.3	
160		80 2.0 2.4	58 2.1 2.9	45 2.3 3.4	32 2.5 4.1	26 2.7 4.5	21 3.0 4.9	17 3.3 5.4	14 3.6 5.8
170		85 2.0 2.4	61 2.1 2.9	47 2.3 3.4	34 2.5 4.1	28 2.7 4.5	22 3.0 5.0	18 3.3 5.4	15 3.6 5.8
180		89 2.0 2.4	65 2.1 2.9	50 2.3 3.4	36 2.5 4.1	29 2.7 4.5	24 3.0 5.0	19 3.3 5.5	16 3.6 5.9
190		94 2.0 2.4	68 2.1 2.9	53 2.3 3.4	38 2.5 4.1	31 2.7 4.6	25 3.0 5.0	21 3.3 5.5	17 3.6 5.9
200		99 2.0 2.4	72 2.1 3.0	55 2.3 3.4	40 2.5 4.1	33 2.7 4.6	26 3.0 5.0	22 3.2 5.5	18 3.6 5.9
220			79 2.1 3.0	61 2.3 3.4	44 2.5 4.1	36 2.7 4.6	29 3.0 5.0	24 3.2 5.5	19 3.6 5.9
240			86 2.1 3.0	66 2.3 3.4	48 2.5 4.1	39 2.7 4.6	32 3.0 5.0	26 3.2 5.5	21 3.6 6.0
260			93 2.1 3.0	72 2.3 3.4	52 2.5 4.1	42 2.7 4.6	34 3.0 5.0	28 3.2 5.5	23 3.6 6.0
280				77 2.3 3.4	56 2.5 4.1	45 2.7 4.6	37 3.0 5.0	30 3.2 5.5	24 3.5 6.0
300				83 2.3 3.5	60 2.5 4.1	49 2.7 4.6	39 3.0 5.0	32 3.2 5.5	26 3.5 6.0

T = Depth, Retardance "C"
D = Depth, Retardance "C"
V_2 = Velocity, Retardance "C"
V_1 = Velocity, Retardance "D"

(Settlement to be added to top of ridge)

Table 6-4.4 - Parabolic diversion design chart (Sheet 3 of 6)

V_1 Based on Permissible Velocity of the Soil With Retardance "D"

Top Width, Depth & V_2 Based on Retardance "C" Grade = 1.0%

Q	V_1 = 2.0	V_1 = 2.5	V_1 = 3.0	V_1 = 3.5	V_1 = 4.0	V_1 = 4.5	V_1 = 5.0	V_1 = 5.5	V_1 = 6.0
cfs	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2
15	16 1.6 1.5	10 1.8 2.0							
20	22 1.6 1.5	13 1.8 2.1							
25	27 1.6 1.5	17 1.8 2.1	11 2.0 2.6						
30	32 1.6 1.5	20 1.8 2.1	13 2.0 2.7	11 2.1 3.0					
35	37 1.6 1.5	23 1.8 2.2	15 2.0 2.8	12 2.1 3.1					
40	43 1.6 1.5	26 1.8 2.2	17 1.9 2.8	14 2.1 3.1	10 2.3 3.7				
45	48 1.6 1.5	29 1.8 2.2	19 1.9 2.8	16 2.1 3.2	12 2.3 3.7				
50	53 1.6 1.5	33 1.8 2.2	22 1.9 2.8	17 2.1 3.2	13 2.3 3.7	10 2.5 4.2			
55	58 1.6 1.5	36 1.8 2.2	24 1.9 2.8	19 2.0 3.3	14 2.3 3.8	11 2.5 4.3			
60	64 1.6 1.5	39 1.8 2.2	26 1.9 2.8	21 2.0 3.3	15 2.2 3.8	12 2.5 4.3			
65	69 1.6 1.5	42 1.8 2.2	28 1.9 2.8	22 2.0 3.3	17 2.2 3.8	13 2.5 4.3	10 2.7 4.7		
70	74 1.6 1.5	45 1.8 2.2	30 1.9 2.8	24 2.0 3.3	18 2.2 3.9	14 2.5 4.4	11 2.7 4.7		
75	79 1.6 1.5	49 1.8 2.2	32 1.9 2.9	26 2.0 3.3	19 2.2 3.9	15 2.5 4.5	12 2.7 4.7		
80	84 1.6 1.5	52 1.8 2.2	34 1.9 2.9	27 2.0 3.3	20 2.2 3.9	16 2.5 4.5	13 2.7 4.9		
90	95 1.6 1.5	58 1.8 2.2	38 1.9 2.9	31 2.0 3.3	23 2.2 3.9	17 2.4 4.5	14 2.7 4.9	12 2.9 5.2	
100		65 1.8 2.2	43 1.9 2.9	34 2.0 3.3	25 2.2 3.9	19 2.4 4.5	16 2.7 4.9	13 2.9 5.3	
110		71 1.8 2.2	47 1.9 2.9	37 2.0 3.3	28 2.2 3.9	21 2.4 4.5	17 2.6 5.0	14 2.9 5.3	12 3.1 5.7
120		77 1.8 2.2	51 1.9 2.9	41 2.0 3.3	30 2.2 4.0	23 2.4 4.5	19 2.6 5.0	16 2.9 5.4	13 3.1 5.7
130		84 1.8 2.2	55 1.9 2.9	44 2.0 3.3	33 2.2 4.0	25 2.4 4.5	20 2.6 5.0	17 2.9 5.4	14 3.1 5.8
140		90 1.8 2.2	59 1.9 2.9	47 2.0 3.3	35 2.2 4.0	27 2.4 4.5	22 2.6 5.0	18 2.8 5.5	15 3.1 5.8
150		96 1.8 2.2	64 1.9 2.9	51 2.0 3.3	38 2.2 4.0	29 2.4 4.5	23 2.6 5.0	19 2.8 5.5	17 3.1 5.8
160			68 1.9 2.9	54 2.0 3.3	40 2.2 4.0	30 2.4 4.5	25 2.6 5.0	20 2.8 5.5	18 3.0 6.0
170			72 1.9 2.9	57 2.0 3.3	43 2.2 4.0	32 2.4 4.5	26 2.5 5.0	22 2.8 5.5	19 3.0 6.0
180			76 1.9 2.9	61 2.0 3.4	45 2.2 4.0	34 2.4 4.5	28 2.6 5.0	23 2.8 5.5	20 3.0 6.0
190			80 1.9 2.9	64 2.0 3.4	48 2.2 4.0	36 2.4 4.5	29 2.6 5.0	24 2.8 5.5	21 3.0 6.0
200			84 1.9 2.9	67 2.0 3.4	50 2.2 4.0	38 2.4 4.5	31 2.6 5.0	25 2.8 5.5	22 3.0 6.0
220			93 1.9 2.9	74 2.0 3.4	55 2.2 4.0	42 2.4 4.5	34 2.6 5.0	28 2.8 5.5	24 3.0 6.0
240				81 2.0 3.4	60 2.2 4.0	45 2.4 4.5	37 2.6 5.0	30 2.8 5.5	26 3.0 6.0
260				87 2.0 3.4	65 2.2 4.0	49 2.4 4.5	40 2.6 5.0	33 2.8 5.5	28 3.0 6.0
280				94 2.0 3.4	70 2.2 4.0	53 2.4 4.5	43 2.6 5.0	36 2.8 5.5	30 3.0 6.0
300					75 2.2 4.0	57 2.4 4.5	46 2.5 5.0	38 2.8 5.5	32 3.0 6.0

T = Top Width, Retardance "C"
D = Depth, Retardance "C"
V_2 = Velocity, Retardance "C"
V_1 = Velocity, Retardance "D"

(Settlement to be added to top of ridge.)

Table 6-4.4 - Parabolic diversion design chart (Sheet 4 of 6)

V_1 Based on Permissible Velocity of the Soil With Retardance "D"

Top Width, Depth & V_2 Based on Retardance "C" Grade = 1.5%

Q	V_1 = 2.0	V_1 = 2.5	V_1 = 3.0	V_1 = 3.5	V_1 = 4.0	V_1 = 4.5	V_1 = 5.0	V_1 = 5.5	V_1 = 6.0
cfs	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2
15	21 1.4 1.4	14 1.6 1.9							
20	28 1.4 1.4	18 1.5 1.9	12 1.7 2.5						
25	35 1.4 1.4	23 1.5 1.9	15 1.7 2.6	10 1.9 3.2					
30	42 1.4 1.4	27 1.5 1.9	18 1.7 2.6	12 1.8 3.2	10 2.0 3.6				
35	49 1.4 1.4	32 1.5 2.0	21 1.6 2.6	14 1.8 3.3	11 1.9 3.7	10 2.1 4.1			
40	56 1.4 1.4	36 1.5 2.0	24 1.6 2.6	16 1.8 3.3	13 1.9 3.7	11 2.1 4.2			
45	63 1.4 1.4	41 1.5 2.0	27 1.6 2.6	18 1.8 3.4	15 1.9 3.8	12 2.0 4.3			
50	70 1.4 1.4	45 1.5 2.0	30 1.6 2.7	20 1.8 3.4	16 1.9 3.9	13 2.0 4.3	10 2.3 4.8		
55	76 1.4 1.5	50 1.5 2.0	33 1.6 2.7	22 1.8 3.4	18 1.9 3.9	14 2.0 4.3	11 2.3 4.9		
60	83 1.4 1.5	54 1.5 2.0	35 1.6 2.7	24 1.8 3.4	19 1.9 3.9	16 2.0 4.4	12 2.3 4.9	10 2.4 5.2	
65	90 1.4 1.5	58 1.5 2.0	38 1.6 2.7	26 1.8 3.4	21 1.9 3.9	17 2.0 4.4	13 2.2 5.0	11 2.4 5.3	
70	97 1.4 1.5	63 1.5 2.0	41 1.6 2.7	28 1.8 3.4	22 1.9 3.9	18 2.0 4.4	14 2.2 5.0	12 2.4 5.4	10 2.6 5.6
75		67 1.5 2.0	44 1.6 2.7	30 1.8 3.4	24 1.9 3.9	19 2.0 4.4	15 2.2 5.0	12 2.4 5.4	11 2.6 5.6
80		72 1.5 2.0	47 1.6 2.7	32 1.8 3.4	26 1.9 3.9	21 2.0 4.4	16 2.2 5.0	13 2.4 5.4	12 2.5 5.8
90		80 1.5 2.0	53 1.6 2.7	36 1.8 3.5	29 1.9 3.9	23 2.0 4.4	18 2.2 5.0	15 2.4 5.4	13 2.5 5.9
100		89 1.5 2.0	59 1.6 2.7	39 1.8 3.5	32 1.9 3.9	26 2.0 4.5	20 2.2 5.0	17 2.4 5.4	14 2.5 6.0
110		98 1.5 2.0	64 1.6 2.7	43 1.8 3.5	35 1.9 3.9	28 2.0 4.5	22 2.2 5.0	18 2.3 5.5	15 2.5 6.0
120			70 1.6 2.7	47 1.8 3.5	38 1.9 4.0	31 2.0 4.5	24 2.2 5.0	20 2.3 5.5	17 2.5 6.0
130			76 1.6 2.7	51 1.8 3.5	41 1.9 4.0	33 2.0 4.5	26 2.2 5.0	21 2.3 5.5	18 2.5 6.0
140			82 1.6 2.7	55 1.8 3.5	44 1.9 4.0	36 2.0 4.5	27 2.2 5.0	23 2.3 5.5	19 2.5 6.0
150			87 1.6 2.7	59 1.8 3.5	47 1.9 4.0	39 2.0 4.5	29 2.2 5.0	25 2.3 5.5	21 2.5 6.0
160			93 1.6 2.7	63 1.8 3.5	51 1.9 4.0	41 2.0 4.5	31 2.2 5.0	26 2.3 5.5	22 2.5 6.0
170			99 1.6 2.7	67 1.8 3.5	54 1.9 4.0	44 2.0 4.5	33 2.2 5.0	28 2.3 5.5	23 2.5 6.0
180				70 1.8 3.5	57 1.9 4.0	46 2.0 4.5	35 2.2 5.0	29 2.3 5.5	25 2.5 6.0
190	T = Top width, Retardance "C"			74 1.8 3.5	60 1.9 4.0	49 2.0 4.5	37 2.2 5.0	31 2.3 5.5	26 2.5 6.0
200	D = Depth, Retardance "C"			78 1.8 3.5	63 1.9 4.0	51 2.0 4.5	39 2.2 5.0	33 2.3 5.5	27 2.5 6.0
220	V_2 = Velocity, Retardance "C"			86 1.8 3.5	69 1.9 4.0	56 2.0 4.5	43 2.2 5.0	36 2.3 5.5	30 2.5 6.0
240	V_1 = Velocity, Retardance "D"			93 1.8 3.5	75 1.9 4.0	61 2.0 4.5	47 2.2 5.0	39 2.3 5.5	33 2.5 6.0
260					82 1.9 4.0	66 2.0 4.5	51 2.2 5.0	42 2.3 5.5	35 2.5 6.0
280	(Settlement to be added to top of ridge.)				88 1.9 4.0	71 2.0 4.5	54 2.2 5.0	46 2.3 5.5	38 2.5 6.0
300					94 1.9 4.0	76 2.0 4.5	58 2.2 5.0	49 2.3 5.5	41 2.5 6.0

Table 6-4.4 - Parabolic diversion design chart (Sheet 5 of 6)

V_1 Based on Permissible Velocity of the Soil With Retardance "D"

Top Width, Depth & V_2 Based on Retardance "C" Grade = 2.0%

Q	V_1 = 2.0	V_1 = 2.5	V_1 = 3.0	V_1 = 3.5	V_1 = 4.0	V_1 = 4.5	V_1 = 5.0	V_1 = 5.5	V_1 = 6.0
cfs	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2	T D V_2
15	27 1.3 1.3	16 1.4 1.9	11 1.5 2.4						
20	35 1.3 1.3	21 1.4 1.9	15 1.5 2.4	11 1.6 3.0					
25	44 1.3 1.3	27 1.4 1.9	19 1.5 2.4	13 1.6 3.0	10 1.8 3.7				
30	53 1.3 1.3	32 1.4 1.9	23 1.5 2.5	16 1.6 3.0	11 1.7 3.7	10 1.8 4.2			
35	61 1.3 1.3	37 1.4 1.9	26 1.5 2.5	19 1.6 3.1	13 1.7 3.8	11 1.8 4.2			
40	70 1.3 1.3	42 1.4 1.9	30 1.5 2.5	21 1.6 3.1	15 1.7 3.8	12 1.8 4.3	10 2.0 4.7		
45	78 1.3 1.4	48 1.4 1.9	34 1.5 2.5	24 1.6 3.1	17 1.7 3.8	14 1.8 4.3	11 1.9 4.8		
50	87 1.3 1.4	53 1.4 1.9	38 1.5 2.5	26 1.6 3.1	19 1.7 3.8	15 1.8 4.3	13 1.9 4.8	10 2.1 5.3	
55	95 1.3 1.4	58 1.4 1.9	41 1.5 2.5	29 1.6 3.1	21 1.7 3.8	17 1.8 4.3	14 1.9 4.9	11 2.1 5.3	
60		63 1.4 1.9	45 1.5 2.5	32 1.6 3.1	23 1.7 3.9	18 1.8 4.4	15 1.9 4.9	12 2.1 5.3	10 2.2 5.7
65		68 1.4 1.9	49 1.5 2.5	34 1.6 3.1	24 1.7 3.9	20 1.8 4.4	16 1.9 4.9	13 2.1 5.4	11 2.2 5.7
70		73 1.4 1.9	52 1.5 2.5	37 1.6 3.1	26 1.7 3.9	22 1.8 4.4	18 1.9 4.9	14 2.1 5 4	12 2.2 5.8
75		78 1.4 1.9	56 1.5 2.5	39 1.6 3.1	28 1.7 3.9	23 1.8 4.4	19 1.9 4.9	15 2.1 5.4	13 2.2 5.9
80		83 1.4 2.0	60 1.5 2.5	42 1.6 3.1	30 1.7 3.9	24 1.8 4.4	20 1.9 4.9	16 2.1 5.4	14 2.2 5.9
90		94 1.4 2.0	67 1.5 2.5	47 1.6 3.2	34 1.7 3.9	28 1.8 4.4	22 1.9 4.9	18 2.1 5.5	15 2.2 5.9
100			74 1.5 2.5	52 1.6 3.2	37 1.7 3.9	31 1.8 4.4	25 1.9 5.0	20 2.1 5.5	17 2.2 6.0
110			81 1.5 2.5	57 1.6 3.2	41 1.7 3.9	34 1.8 4.4	27 1.9 5.0	22 2.0 5.5	19 2.2 6.0
120			89 1.5 2.5	62 1.6 3.2	45 1.7 3.9	37 1.8 4.4	30 1.9 5.0	24 2.0 5.5	20 2.2 6.0
130			96 1.5 2.5	67 1.6 3.2	48 1.7 3.9	40 1.8 4.5	32 1.9 5.0	26 2.0 5.5	22 2.2 6.0
140				73 1.6 3.2	52 1.7 4.0	42 1.8 4.5	35 1.9 5.0	28 2.0 5.5	23 2.2 6.0
150				78 1.6 3.2	56 1.7 4.0	46 1.8 4.5	37 1.9 5.0	30 2.0 5.5	25 2.2 6.0
160				83 1.6 3.2	59 1.7 4.0	48 1.8 4.5	39 1.9 5.0	32 2.0 5.5	27 2.2 6.0
170				88 1.6 3.2	63 1.7 4.0	51 1.8 4.5	42 1.9 5.0	34 2.0 5.5	28 2.2 6.0
180				93 1.6 3.2	67 1.7 4.0	54 1.8 4.5	44 1.9 5.0	36 2.0 5.5	30 2.2 6.0
190				98 1.6 3.2	70 1.7 4.0	57 1.8 4.5	47 1.9 5.0	38 2.0 5.5	32 2.2 6.0
200					74 1.7 4.0	60 1.8 4.5	49 1.9 5.0	40 2.0 5.5	33 2.2 6.0
220					81 1.7 4.0	66 1.8 4.5	54 1.9 5.0	44 2.0 5.5	37 2.2 6.0
240					88 1.7 4.0	72 1.8 4.5	59 1.9 5.0	48 2.0 5.5	40 2.2 6.0
260					96 1.7 4.0	78 1.8 4.5	64 1.9 5.0	51 2.0 5.5	43 2.2 6.0
280						84 1.8 4.5	69 1.9 5.0	55 2.0 5.5	46 2.2 6.0
300						90 1.8 4.5	73 1.9 5.0	59 2.0 5.5	50 2.2 6.0

T = Top width, Retardance "C"
D = Depth, Retardance "C"
V_2 = Velocity, Retardance "C"
V_1 = Velocity, Retardance "D"

(Settlement to be added to top of ridge.)

Table 6-4.4 -Parabolic diversion design chart (Sheet 6 of 6)

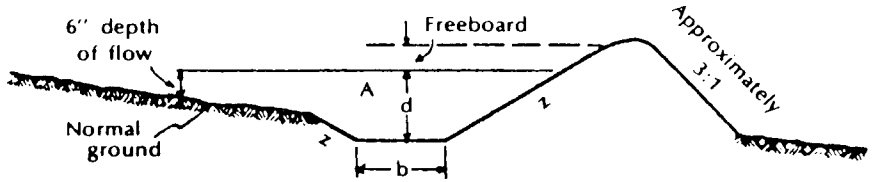
• 3:1 Side Slopes
"D" Retardance

Grade	6' bottom width								8' bottom width								10' bottom width								12' bottom width							
	0.2		0.3		0.4		0.5		0.2		0.3		0.4		0.5		0.2		0.3		0.4		0.5		0.2		0.3		0.4		0.5	
Q-cfs	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A
10	1.3	12	1.1	10	1.0	9	0.9	8	1.2	13	1.1	11	1.0	10	0.9	9	1.1	14	1.0	12	0.9	11	0.8	10	1.0	14	0.9	12	0.8	11	0.7	10
20	1.5	16	1.4	14	1.2	12	1.1	10	1.4	17	1.3	16	1.2	14	1.1	12	1.3	18	1.2	16	1.0	13	0.9	11	1.2	19	1.1	17	1.0	15	0.9	13
30	1.8	21	1.6	17	1.5	16	1.3	13	1.7	22	1.5	19	1.4	17	1.2	14	1.5	22	1.4	20	1.2	16	1.1	15	1.3	21	1.2	19	1.2	19	1.1	17
40	2.0	24	1.8	21	1.7	19	1.5	16	1.8	24	1.7	22	1.5	19	1.4	17	1.7	26	1.5	22	1.4	20	1.2	16	1.6	27	1.5	25	1.3	21	1.2	19
60	2.3	30	2.1	26	1.9	22	1.7	19	2.1	30	1.9	26	1.8	24	1.6	21	2.0	32	1.8	28	1.7	26	1.5	22	1.8	31	1.6	27	1.5	25	1.3	21
80	2.5	34	2.3	30	2.1	26	1.9	22	2.4	37	2.2	32	2.0	28	1.8	24	2.3	39	2.1	34	1.9	30	1.7	26	2.1	38	1.9	34	1.8	31	1.6	27
100	2.8	40	2.5	34	2.3	30	2.1	26	2.6	41	2.4	37	2.2	32	2.0	28	2.4	41	2.2	37	2.1	34	1.9	30	2.3	44	2.1	38	1.9	34	1.7	29
120	3.0	45	2.8	40	2.5	34	2.3	30	2.8	46	2.5	39	2.3	34	2.1	30	2.6	46	2.4	41	2.2	37	2.0	32	2.5	50	2.3	44	2.1	38	1.9	34
140			2.9	43	2.6	36	2.4	32	2.9	48	2.7	44	2.5	39	2.3	34	2.7	49	2.5	44	2.3	39	2.1	34	2.6	52	2.4	46	2.2	41	2.0	36
160			3.0	45	2.8	40	2.6	36	3.1	51	2.9	48	2.7	44	2.5	39	2.9	54	2.7	49	2.5	44	2.3	39	2.7	54	2.5	50	2.3	44	2.1	38
180															2.6	41	3.0	57	2.8	51	2.6	46	2.4	41	2.8	57	2.6	52	2.4	46	2.2	41
200																							2.5	44	2.9	60	2.7	54	2.5	50	2.3	44
220																									3.0	63	2.8	57	2.7	54	2.5	50

NOTE: For diversions built on slopes under 2% the available cross-sectional area above normal ground will allow a reduction in design depth as follows:

For land slopes of 1% or less reduce depth of flow (taken from Design Table) 20%.
For land slopes of 1% to 2% reduce depth of flow (taken from Design Table) 10%.
For land slopes greater than 2% use depth of flow taken from Design Table.

For Example: A diversion 6 feet wide with a 2.5 foot depth of flow is required to remove 120 c.f.s. on a 0.4% grade. If this is built on a 1% slope the depth may be reduced 20% thus obtaining a flow depth of 2.0 feet. The required cross-sectional area of the channel plus that above normal ground line will be 34 square feet corresponding to the 2.5 foot depth. The overall height of diversion will be 2.0 feet plus 0.5 foot freeboard or 2.5 feet, instead of the original 3.0 feet.



d = depth of flow, feet
b = bottom width of channel, feet
A = channel capacity, sq. ft., including area below 0.5' freeboard and excluding any area less than 0.5' depth of flow
z = side slope of channel (horizontal to vertical)

IMPORTANT: To all designed depths of flow add freeboard required by State Standards and Specifications to obtain overall height of terrace above bottom of channel. For final check on cross-sectional area subtract required freeboard from settled height of diversion and provide for cross-sectional area shown in table.

Table 6-4.5 - Diversion design table - "D" Retardance (Trapezoidal Section) (Sheet 1 of 2)

• 4:1 Side Slopes
"D" Retardance

	6' bottom width								8' bottom width								10' bottom width								12' bottom width							
Grade	0.2		0.3		0.4		0.5		0.2		0.3		0.4		0.5		0.2		0.3		0.4		0.5		0.2		0.3		0.4		0.5	
Q-cfs	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A
10	1.2	13	1.1	11	1.0	10	0.9	9	1.1	14	1.0	13	0.9	11	0.8	10	1.1	14	1.0	13	0.9	12	0.8	11	1.0	15	0.9	14	0.8	13	0.7	12
20	1.5	18	1.4	16	1.2	13	1.1	11	1.4	19	1.3	17	1.2	15	1.1	14	1.3	20	1.2	18	1.0	14	0.9	12	1.2	20	1.1	18	1.0	16	0.9	14
30	1.8	24	1.6	20	1.5	18	1.3	15	1.7	25	1.5	21	1.4	19	1.2	15	1.5	24	1.4	22	1.2	18	1.1	16	1.3	22	1.2	20	1.2	20	1.1	18
40	1.9	26	1.8	24	1.6	20	1.5	18	1.8	27	1.7	25	1.5	21	1.4	19	1.6	26	1.5	24	1.3	20	1.2	18	1.6	29	1.5	27	1.3	22	1.2	20
60	2.2	33	2.0	28	1.9	26	1.7	22	2.0	32	1.9	30	1.7	25	1.6	23	1.9	33	1.8	31	1.6	26	1.5	24	1.7	32	1.6	29	1.4	25	1.3	22
80	2.4	37	2.2	33	2.1	30	1.9	26	2.3	40	2.1	34	2.0	32	1.8	27	2.2	41	2.0	36	1.8	31	1.6	26	2.0	40	1.9	37	1.7	32	1.6	29
100	2.7	45	2.5	40	2.3	35	2.1	30	2.5	45	2.3	40	2.1	34	1.9	30	2.3	44	2.1	39	2.0	36	1.8	31	2.2	46	2.0	40	1.9	37	1.7	32
120	2.9	51	2.7	45	2.4	37	2.2	33	2.7	51	2.5	45	2.3	40	2.1	34	2.5	50	2.3	44	2.2	41	2.0	36	2.4	52	2.2	46	2.0	40	1.8	35
140	3.0	54	2.8	48	2.6	43	2.4	37	2.8	54	2.6	48	2.5	45	2.3	40	2.6	53	2.4	47	2.3	44	2.1	39	2.5	55	2.3	49	2.2	46	2.0	40
160	3.1	57	2.9	51	2.8	48	2.6	43	3.0	60	2.8	54	2.6	48	2.4	42	2.8	59	2.6	53	2.5	50	2.3	44	2.7	62	2.5	55	2.3	49	2.1	43
180															2.5	45	2.9	63	2.7	56	2.6	53	2.4	47	2.8	65	2.6	58	2.4	52	2.2	46
200																							2.5	50	2.9	68	2.7	62	2.5	55	2.3	49
220																									3.0	72	2.8	65	2.6	58	2.4	52

Table 6-4.5 - Diversion design table - "D" Retardance (Trapezoidal Section) (Sheet 2 of 2)

• 3:1 Side Slopes
"C" Retardance

Grade	6' bottom								8' bottom								10' bottom								12' bottom							
	0.2		0.3		0.4		0.5		0.2		0.3		0.4		0.5		0.2		0.3		0.4		0.5		0.2		0.3		0.4		0.5	
Q	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A
20	1.9	22	1.7	19	1.5	16	1.4	14	1.7	22	1.5	19	1.4	17	1.3	15	1.6	24	1.4	20	1.3	18	1.2	16								
30	2.0	24	1.8	21	1.7	19	1.5	16	1.9	26	1.7	22	1.5	19	1.4	17	1.7	26	1.5	22	1.4	20	1.3	18	1.6	27	1.4	23	1.3	21	1.2	19
40	2.2	28	2.0	24	1.9	22	1.7	19	2.0	28	1.8	24	1.6	21	1.5	19	1.9	30	1.7	26	1.5	22	1.4	20	1.8	31	1.6	27	1.5	25	1.4	23
50	2.3	30	2.1	26	2.0	24	1.8	21	2.2	32	2.0	28	1.8	24	1.6	21	2.0	32	1.8	28	1.6	24	1.5	22	1.9	34	1.7	29	1.6	27	1.5	25
60	2.5	34	2.3	30	2.1	26	1.9	22	2.3	34	2.1	30	1.9	26	1.8	24	2.2	37	2.0	32	1.8	28	1.6	24	2.0	36	1.8	31	1.7	29	1.6	27
80			2.5	34	2.3	30	2.1	26	2.5	39	2.3	34	2.1	30	1.9	26	2.4	41	2.2	37	2.0	32	1.8	28	2.2	41	2.0	36	1.9	34	1.7	29
100					2.5	34	2.3	30			2.5	39	2.3	34	2.1	30			2.4	41	2.2	37	2.0	32	2.5	49	2.2	41	2.0	36	1.8	31
120							2.5	34					2.5	39	2.3	34					2.3	39	2.1	34			2.4	46	2.2	41	2.0	36
140															2.4	36					2.5	44	2.3	39					2.3	43	2.1	38
160																							2.4	41					2.4	46	2.2	41
180																							2.5	44							2.4	46
200																															2.5	49
220																															2.6	51

• 4:1 Side Slopes
"C" Retardance

Grade	6' bottom width								8' bottom width								10' bottom width								12' bottom width							
	0.2		0.3		0.4		0.5		0.2		0.3		0.4		0.5		0.2		0.3		0.4		0.5		0.2		0.3		0.4		0.5	
Q	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A	d	A
30	2.0	28	1.8	24	1.6	20	1.5	18	1.8	27	1.7	25	1.5	21	1.4	19	1.8	31	1.6	26	1.4	22	1.3	20	1.7	32	1.6	29	1.4	25	1.2	20
40	2.1	30	1.9	26	1.7	22	1.6	20	2.0	32	1.8	27	1.6	23	1.5	21	1.9	33	1.7	29	1.5	24	1.4	22	1.8	35	1.7	32	1.5	27	1.3	22
50	2.3	35	2.1	30	1.9	26	1.7	22	2.1	34	1.9	30	1.7	25	1.6	23	2.0	36	1.8	31	1.6	26	1.5	24	1.9	37	1.8	35	1.6	29	1.4	25
60	2.4	37	2.2	33	2.0	28	1.9	26	2.3	40	2.1	34	1.9	30	1.7	25	2.1	39	1.9	34	1.7	29	1.6	26	2.0	40	1.9	37	1.7	32	1.5	27
80			2.4	37	2.2	33	2.0	28	2.5	45	2.3	40	2.1	34	1.9	30	2.3	44	2.1	39	1.9	34	1.8	31	2.2	46	2.0	40	1.8	35	1.7	32
100			2.5	40	2.3	35	2.2	33			2.5	45	2.3	40	2.0	32	2.5	50	2.3	44	2.1	39	1.9	34	2.3	49	2.1	43	2.0	40	1.8	35
120					2.5	40	2.4	37					2.4	42	2.2	37			2.5	50	2.3	44	2.1	39	2.5	55	2.3	49	2.2	46	2.0	40
140							2.5	40					2.5	45	2.3	40					2.4	47	2.2	41			2.5	55	2.3	49	2.1	43
160															2.5	45					2.5	50	2.3	44					2.4	52	2.2	46
180																							2.4	47					2.5	55	2.3	49
200																							2.5	50							2.4	52
220																															2.5	55

Table 6-4.6 - Diversion design table - "C" Retardance (Trapezoidal Section)

Temporary Downdrain Structure

Dn1

DEFINITION

A pipe used as a temporary structure to convey a concentration of storm water down the face of cut or fill slopes.

PURPOSE

To safely conduct storm runoff from one elevation to another without causing slope erosion.

CONDITIONS

Temporary downdrains are used on slopes where a concentration of storm water would cause erosion damages. These structures are removed once the permanent water disposal system is installed.

DESIGN CRITERIA

(Formal design is generally not required.)

Placement: On undisturbed soil or well-compacted fill.
Diameter: Sufficient capacity required to convey the maximum runoff expected during the life of the drain.
Downdrain Inlet and Outlet: Use a Tee or "L" inlet at the top of the slope. Slope the entrance 1/2" per foot toward the outlet. Thoroughly compact selected soil around the inlet section to prevent the pipe from being washed out by seepage or piping. Stabilize the outlet section with a Tee outlet, rock riprap or other suitable materials. See Figure 6-5.1.
Pipe: Design the slope drain using heavy-duty, flexible materials such as non-perforated, corrugated plastic pipe or specially designed flexible tubing. Use reinforced, hold-down grommets or stakes to anchor the pipe at intervals not to exceed 10 feet with the outlet end securely fastened in place. The pipe must extend beyond the toe of the slope.

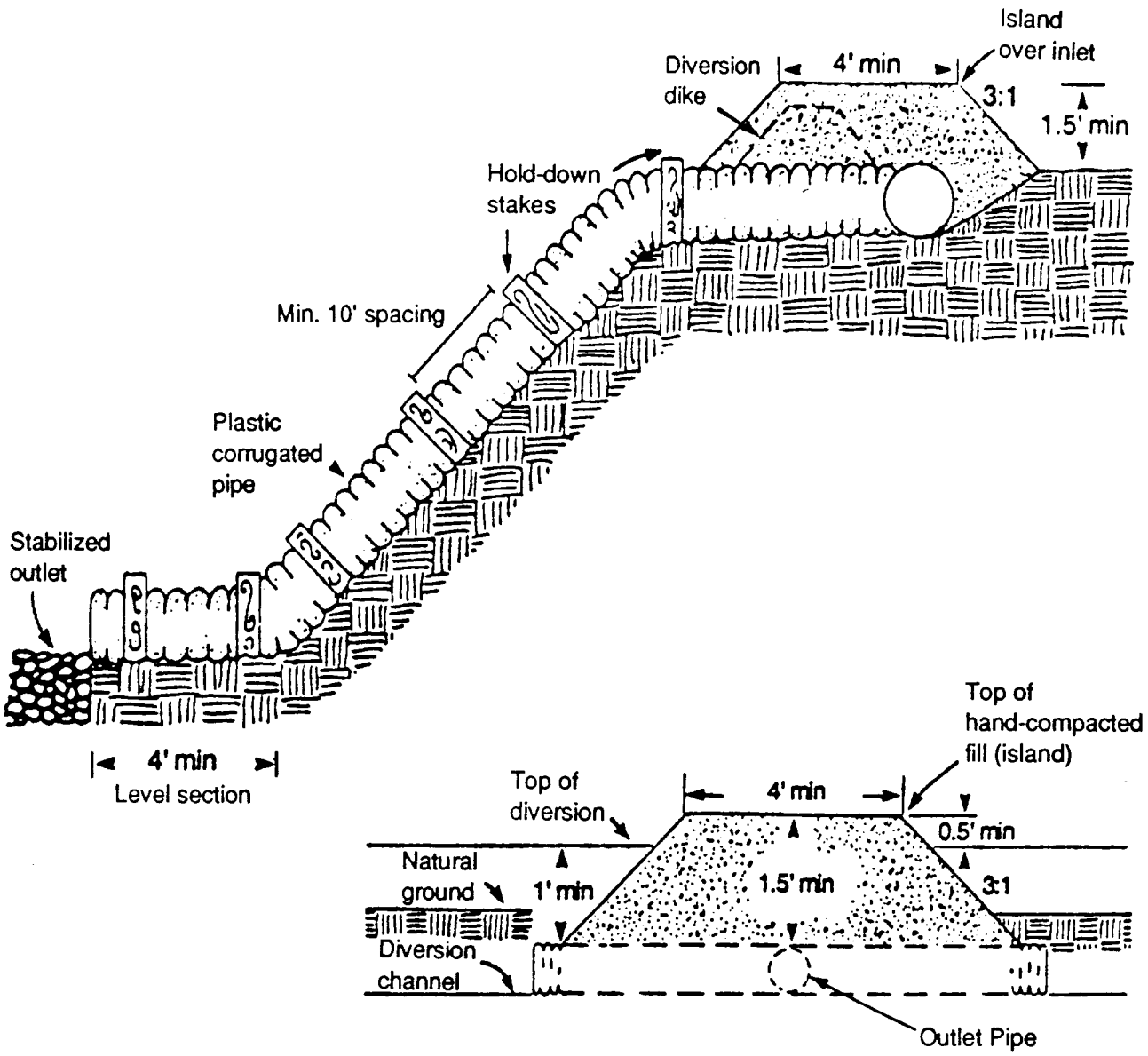
CONSTRUCTION SPECIFICATIONS

A common failure of slope drains is caused by water saturating the soil and seeping along the pipe. This creates voids from consolidation and piping and causes washouts. Proper back-filling around and under the pipe "haunches" with stable soil material and hand compacting in 6-inch lifts to achieve firm contact between the pipe and the soil at all points will eliminate this type of failure.

1. Place slope drains on undisturbed soil or well compacted fill at locations and elevations shown on the plans.
2. Slightly slope the section of pipe under the dike toward its outlet.
3. Hand tamp the soil under and around the entrance section in lifts not to exceed 6 inches.
4. Ensure that fill over the drain at the top of the slope has minimum dimensions of 1.5 ft. depth, 4 ft. top width, and 3:1 side slopes.
5. Ensure that all slope drain connections are watertight.
6. Ensure that all fill material is well-compacted. Securely fasten the exposed section of the drain with grommets or stakes spaced no more than 10 feet apart.
7. Extend the drain beyond the toe of the slope and adequately protect the outlet from erosion.
8. Make the settled, compacted dike ridge no less than 1 foot above the top of the pipe at every point.
9. Immediately stabilize all disturbed areas following construction.

MAINTENANCE

Inspect the slope drain and supporting diversion after every rainfall and promptly make necessary repairs. When the protected area has been permanently stabilized, temporary measures may be removed, materials disposed of properly, and all disturbed areas stabilized appropriately.



Inlet Detail

Make all pipe connections watertight and secure so that the joints will not separate in use.

Typical corrugated plastic pipe diameters are 8 to 10 inches. Use an adequate pipe size or several pipes as needed to remove the expected runoff.

DOWNDRAIN PIPE AND INLET DETAIL

Figure 6-5.1

Permanent Downdrain Structure

Dn2

DEFINITION

A structure to safely convey surface runoff from the top of a slope to the bottom of the slope.

PURPOSE

The purpose of this standard is to convey storm runoff safely down cut or fill slopes to minimize erosion.

CONDITIONS

This standard includes the following types of structures:

Paved flume: parabolic, rectangular or trapezoidal cross sections.

Pipe: steel, plastic, etc.

Sectional: a prefabricated sectional conduit of half round or third round pipe.

Downdrain structures are to be used where concentrated water will cause excessive erosion on cut and fill slopes. Downdrain structures may be temporary or permanent. See Figure 6-6.1 through 6-6.5.

DESIGN CRITERIA

Capacity

Flumes shall be adequately designed to convey runoff water concentrations safely down steep slopes based on a minimum 25-year, 24-hour storm in accordance with criteria in Appendix A of this manual.

Slope

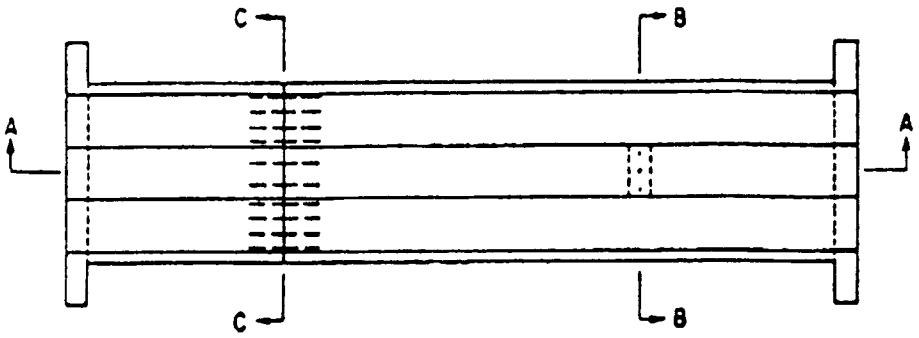
Sufficient to prevent deposit of sediment.

Maintenance

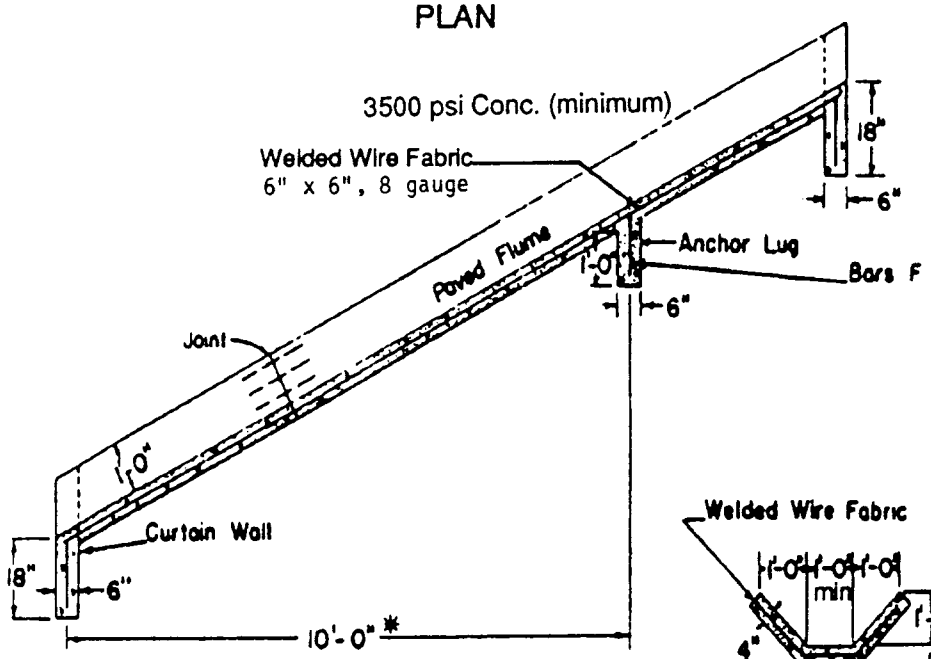
Inspect for damage periodically.

Outlet Stabilization Structure

Outlets must be stabilized using criteria in Storm Drain Outlet Protection, St.



PLAN



SECTION A-A

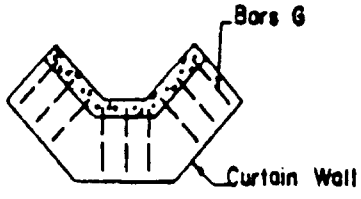
SECTION B-B

*10'-0" C-C maximum typical spacing between Anchor Lugs. Where Curtain Wall is not required, Anchor Lug is to be a maximum of 2" from end of channel.

SCHEDULE OF REINFORCING STEEL

MARK	NO.	LENGTH 2:1	LENGTH N/1	SIZE	SPACING C-C	SHAPE
F	3	1'-2"	1'-2"	4	4"	Straight
G	9	1'-5"	1'-5"	4	6"	Straight
Dowels	10	1'-6"	1'-6"	4	5"	Straight

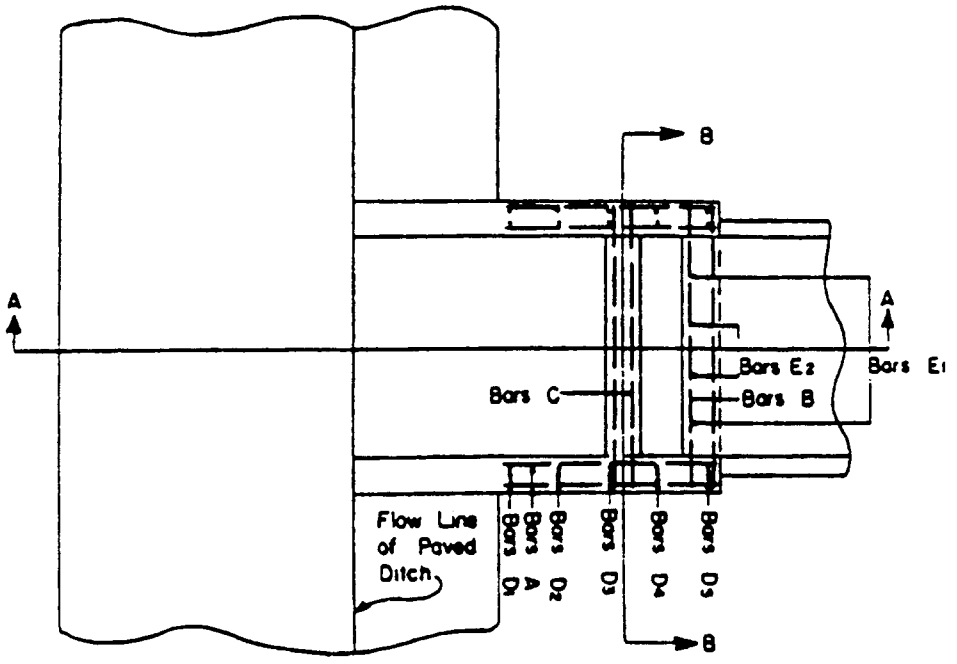
No. shown are for one anchor lug, curtain wall and joint



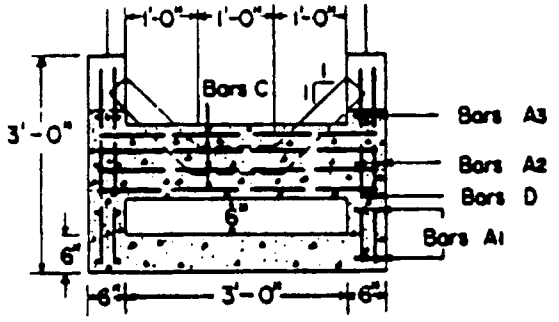
SECTION C-C

TYPICAL CONCRETE PAVED FLUME

Figure 6-6.1



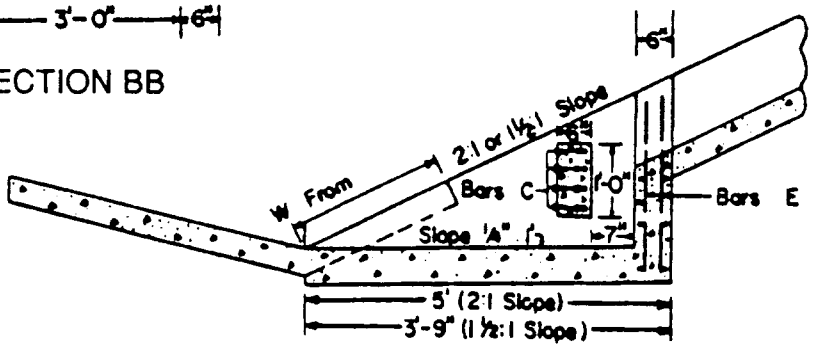
PLAN



SECTION BB

This item may be precast or cast in place.

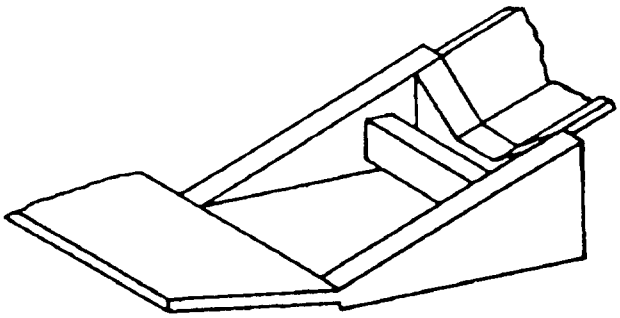
Concrete is to be 28 day 3500 psi, minimum.



SECTION AA

TYPICAL CONCRETE ENERGY DISSIPATOR

Figure 6-6.2



ISOMETRIC

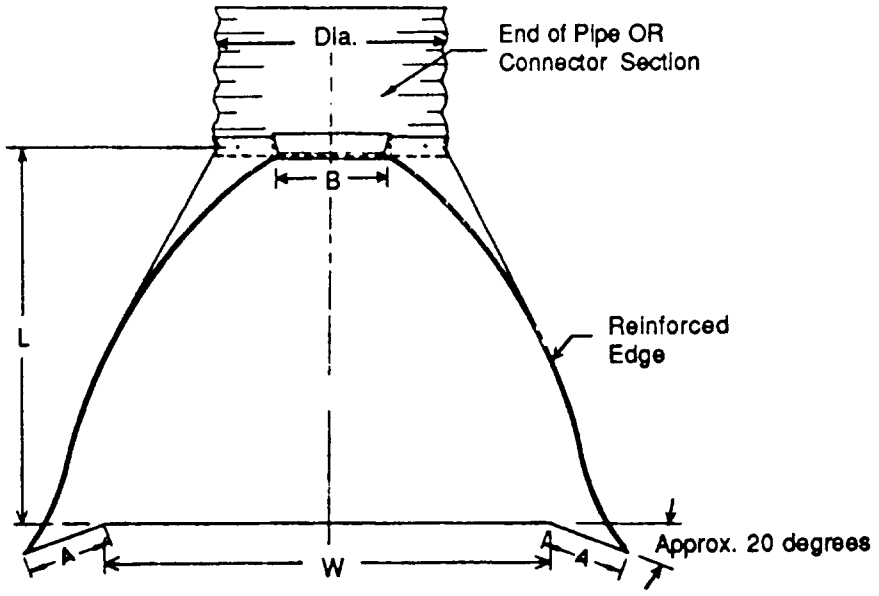
SCHEDULE OF REINFORCING STEEL

MARK	NO.	LENGTH		SIZE	SPACING C – C	SHAPE
		2 : 1	1½ : 1			
A1	8	2'-10"	2'-10"	3	8"	Straight
A2	4	2'-6¼"	1'-10"	3	8"	Straight
A3	4	1'-0¾"	0'-10"	3	8"	Straight
B	6	3'-9"	3'-9"	3	8"	Straight
C	8	3'-8"	3'-8"	4	2½"	Straight
D1	4	1'-2½"	0'-8"	3	8"	Straight
D2	4	1'-6½"	1'-1½"	3	8"	Straight
D3	4	1'-10½"	1'-7"	3	8"	Straight
D4	4	2'-2½"	2'-0½"	3	8"	Straight
D5	4	2'-6½"	2'-6"	3	8"	Straight
E1	4	1'-11½"	1'-11½"	3	8"	Straight
E2	4	1'-5½"	1'-5½"	3	8"	Straight

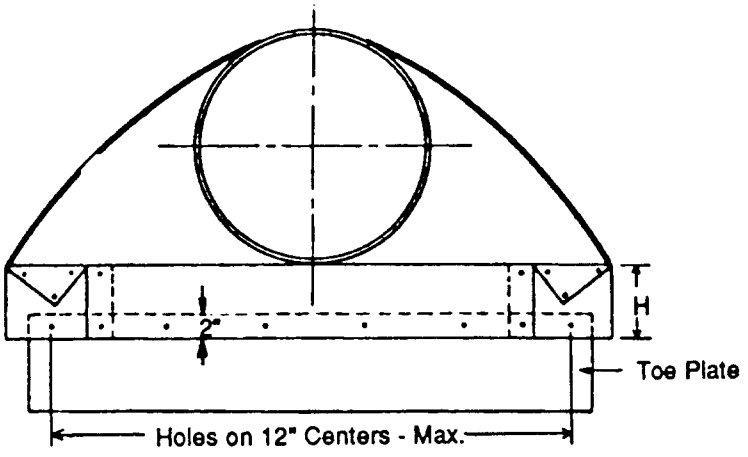
APPROXIMATE QUANTITIES			
		Concrete	Reinforcing Steel
		Cu. Yds.	Lbs.
Energy Dissipator	2 : 1	0.7479	61.20
	1½ : 1	0.5921	57.63

TYPICAL CONCRETE ENERGY DISSIPATOR (CONTINUED)

Figure 6-6.3



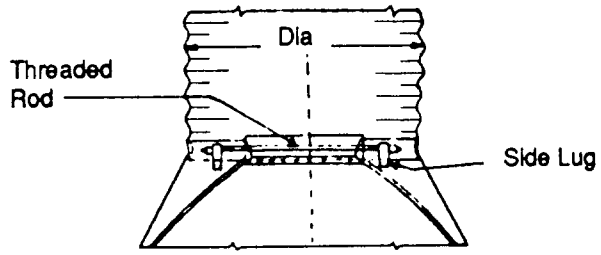
PLAN VIEW



ELEVATION

FLARED END-SECTION

Figure 6-6.4

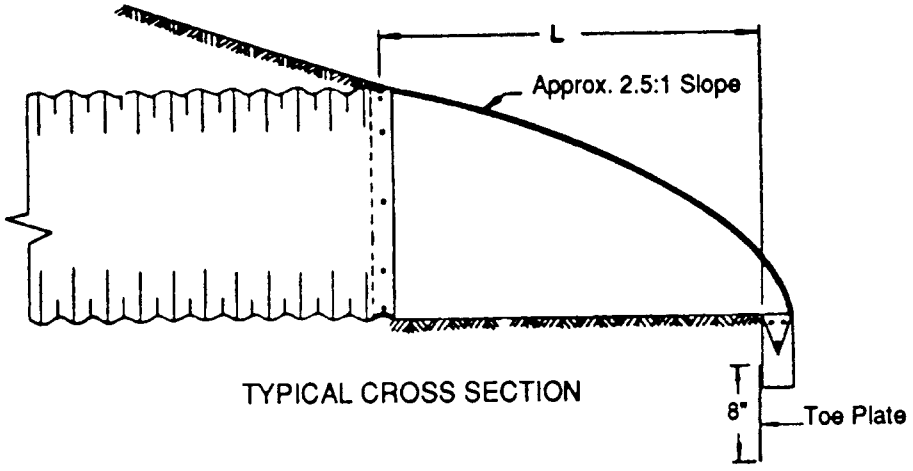


Toe plate, where needed, to be punched to match holes in skirt lip. 3/8" galv bolts to be furnished. Length of toe plate is W + 10".

Skirt Section for pipe to be made in one piece.

Connector Section, Corner Plate, and Toe Plate to be same sheet thickness as skirt.

End-sections and fittings are to be galvanized steel or aluminum alloy for use with like pipe.



TYPICAL CROSS SECTION

CORRUGATED STEEL FLARED SECTION						
PIPE DIA.	GAGE	DIMENSIONS				
		A 1" Tol.	B Max.	H 1" Tol.	L 1.5" Tol.	W 2" Tol.
12"	16	6"	6"	6"	21"	24"
15"	16	7"	8"	6"	26"	30"
18"	16	8"	10"	6"	31"	36"
NOTE: For pipe diameters larger than 18", use manufacturer's standard dimensions.						

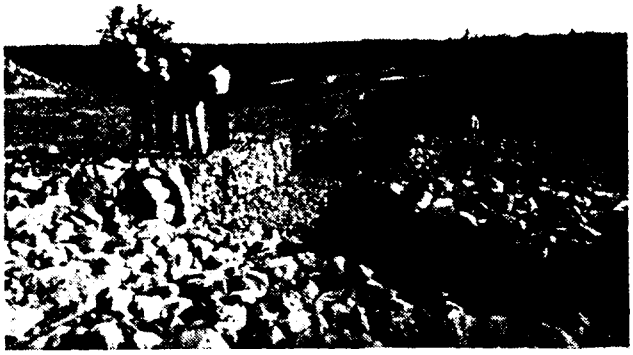
NOTE: Standard manufactured polyethylene 12", 15", 18", and 24" pipe end sections may be used.

FLARED END SECTION (Continued)

Figure 6-6.5

Gabion

Ga



DEFINITION

Gabions are large, multi-celled, rectangular wire mesh boxes, used in channel revetments, retaining walls, abutments, check dams, etc.

PURPOSE

Rock-filled baskets, properly wired together, form flexible monolithic building blocks used for construction of erosion control structures. Gabions are used to stabilize steep or highly erosive slopes.

DESIGN CRITERIA

Construction plans and drawings should be prepared by professionals familiar with the use of gabions. Erosion and sediment control construction design should ensure that foundations are properly prepared to receive gabions, that the gabion structure is securely "keyed" into the foundations and abutment surfaces, and that rock used is durable and adequately sized to be retained in the baskets.

CONSTRUCTION SPECIFICATIONS

How the Gabion is Filled

The gabion is normally filled with hand-sized, 4"-8" pieces of stone, usually dumped into it mechanically. The filled gabion then becomes a large, flexible, and permeable building block from which a broad range of structures may be built. This is done by setting and wiring individual units together in courses and filling them in place.

Corrosion Resistance of Gabions

The wire mesh used in gabions is heavily galvanized. For highly corrosive conditions, a PVC (polyvinyl chloride) coating must be used over the galvanizing. Such treatment is an economical solution to deterioration of the wire near the ocean, in some industrial areas, in polluted streams, and in soils such as muck and peat.

Flexibility

An outstanding advantage of the gabion is its flexibility. Its triple-twist hexagonal mesh construction permits it to tolerate differential settlement without fracture. This property is especially important when a structure is on unstable ground or in areas where scour from waves or currents can undermine it.

Durability

Gabions are durable because they support plant growth which develops a living coating for the wire mesh and stones. Frequently, the wire mesh is only needed for the first few years of the structures life, because the voids between the individual stones fill with soil, silt, and roots which act as a bonding agent for the stones. Furthermore, the triple twisted hexagonal mesh won't unravel if cut.

Strength

Steel wire hexagonal mesh has the strength and flexibility to withstand forces generated by water and earth masses. Also, the pervious nature of the gabion allows it to absorb and dissipate much of the energy developed. This is particularly so on coast protection installations where a compact gabion structure often remains effective long after a massive rigid structure fails.

Permeability

Hydrostatic heads do not develop behind a gabion wall. The wall is pervious to water and stabilizes a slope by the combined action of draining and retaining. Drainage is accomplished by gravity and by evaporation as the porous structure permits an active air circulation through it. Moreover, as plant growth invades the structure, transpiration further assists in removing moisture from the backfill. This system is much more efficient than weep holes in standard masonry walls.

Economy

Gabion installations are more economical than rigid or semi-rigid structures for a number of reasons. The following are among the more important ones.

- Little maintenance is required.
- Gabion construction is simple, does not require skilled labor.
- Preliminary foundation preparation is unnecessary, the surface needs to be only reasonably level and smooth.
- No costly drainage provision is required since gabions are porous.

Landscaping

Because gabions permit the growth of natural vegetation and maintain the natural environment of the area, they provide attractive and natural building blocks for decorative landscaping.

They can be used effectively and economically in parks, along highways, including use as a sound barrier, and around bridge approaches to create walkways, rock gardens, patios, and terraces . . . to beautify the banks of lakes and ponds . . . to accent trees and other plantings.

In fact, their application to decorative landscaping is limited only by the ingenuity of the landscaper.

Typical Installations Include:

- River Training and Flood Control:
  - Gabion Aprons
  - Longitudinal Works
  - Training Walls
  - Revetments
  - Bank Paving
  - Counterforts
  - Drop Structures or Weirs
  - Spurs, Spur Dikes, or Groins
- Channel Linings
- Retaining Walls
- Bridge Abutments and Wings
- Marinas and Boat Ramps
- Culvert Headwalls and Outlet Aprons
- Shore and Beach Protection

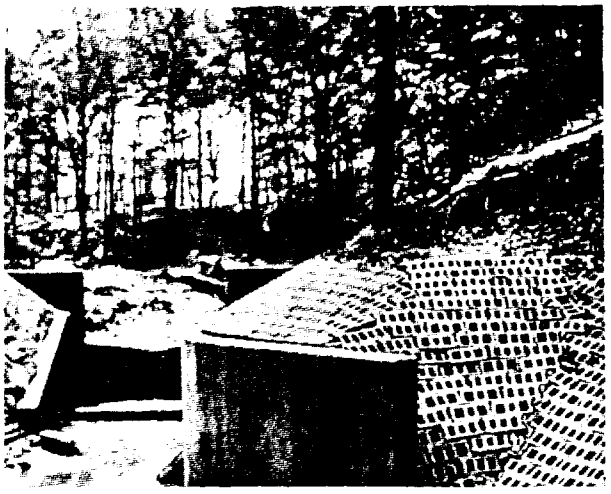
Maintenance

Periodic inspection should be performed for signs of undercutting or excessive erosion at transition areas.

Source: National Crushed Stone Association

Grade Stabilization Structure

Gr



DEFINITION

A structure to stabilize the grade in natural or artificial channels.

PURPOSE

Grade stabilization structures are installed to stabilize the grade in natural or artificial channels, prevent the formation or advance of gullies, and reduce erosion and sediment pollution.

CONDITIONS

This standard applies to sites where structures are needed to stabilize channel grades but does not apply to sites where water is to be impounded.

DESIGN CRITERIA

Structures

Structures of materials such as concrete, rock, masonry, steel, aluminum and treated wood shall be designed in accordance with sound engineering practices. Design data for small reinforced concrete drop spillways and formless concrete chute spillways are contained herein.

Capacity

Structure capacity shall be designed to meet the following requirements:

Overbank Flow Damage to:	Flood Frequency
Residences, commercial buildings, recreation buildings, etc.	100-year, 24-hour storm
Recreation and landscaped areas	25-year, 24-hour storm[1]
Agricultural land	10-year, 24-hour storm[1]

[1]50 percent of peak flood flow may be carried around island-type structures provided overbank flow damage from erosion and flooding can be tolerated. See "Plan view of layout of island-type structure", Figure 6-8.2. Peak flood flow will be determined by methods contained in Appendix A.

Embankments

Earthfill embankments shall have a minimum top width of 10 feet and side slopes of 3:1 or flatter.

Earthfill material shall be moderately to slowly permeable with the most plastic material being used in the center of the embankment and adjacent to structures. Material shall be compacted to approximately 95 percent of standard density. The embankment shall be overbuilt to allow for settlement.

Keyway

A keyway not less than 8 feet wide and 2 feet deep shall be constructed along the centerline of the structure and embankment.

Outlet

All structures shall discharge into stable outlets.

CONSTRUCTION SPECIFICATIONS

Earthfill shall be constructed in 6" to 8" horizontal lifts. Earthfill moisture shall be such that satisfactory compaction can be obtained.

Excavations shall be dewatered prior to filling.

Structures shall be placed on compacted earthfill.

Embankment surfaces shall be completed to the required lines and grades.

Protective cover shall be applied immediately after completion of the structure.

GRADE STABILIZING STRUCTURES

Drop Spillway Design Data

Planning and design of straight drop spillways normally require the assistance of an engineer. Local personnel may be trained to plan and install small drop spillway structures when standard plans are available.

Measurement locations for symbols F (overfall in feet), h (depth of weir in feet), s (depth of stilling pool in feet), and L (length of weir in feet) are shown in Figure 6-8.1

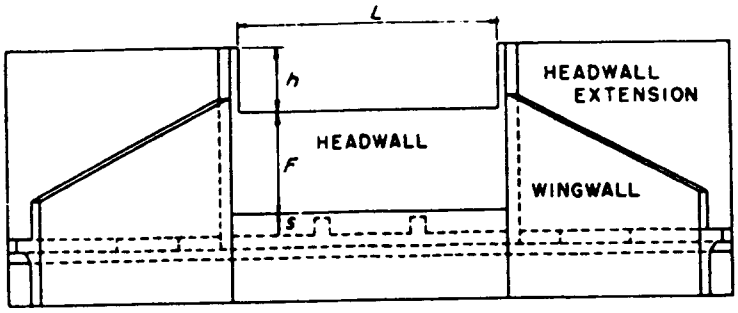


Figure 6-8.1 — Symbols for straight drop spillway.

Weir capacities for low-overfall straight drop spillways can be determined from Figure 6-8.3 for various combinations of F, h, and L.

Island-type Structure

The island-type spillway uses a drop spillway in the channel with auxiliary earth spillways for carrying excess flows around the structure. Either the straight drop spillway or the box inlet drop spillway can be used (Figure 6-8.2). To prevent washing around the structure, dikes or levees extending each way from the structure must be provided.

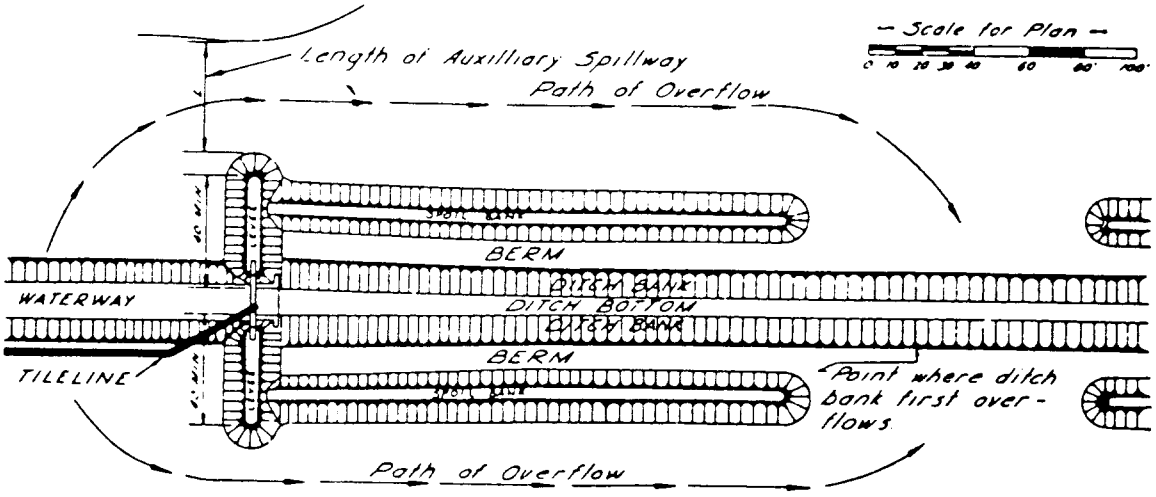
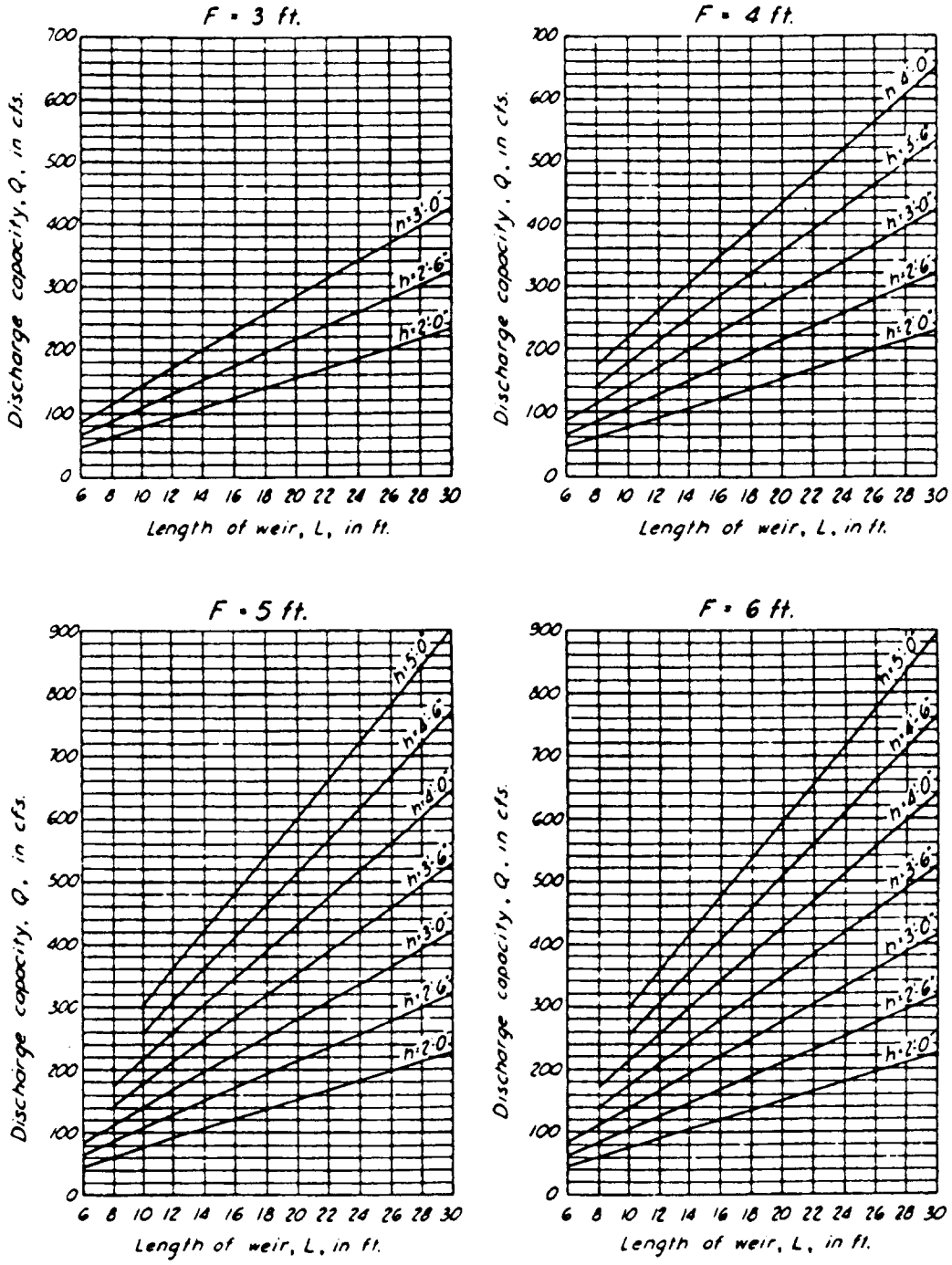


Figure 6-8.2 — Plan view of layout for island-type spillway.



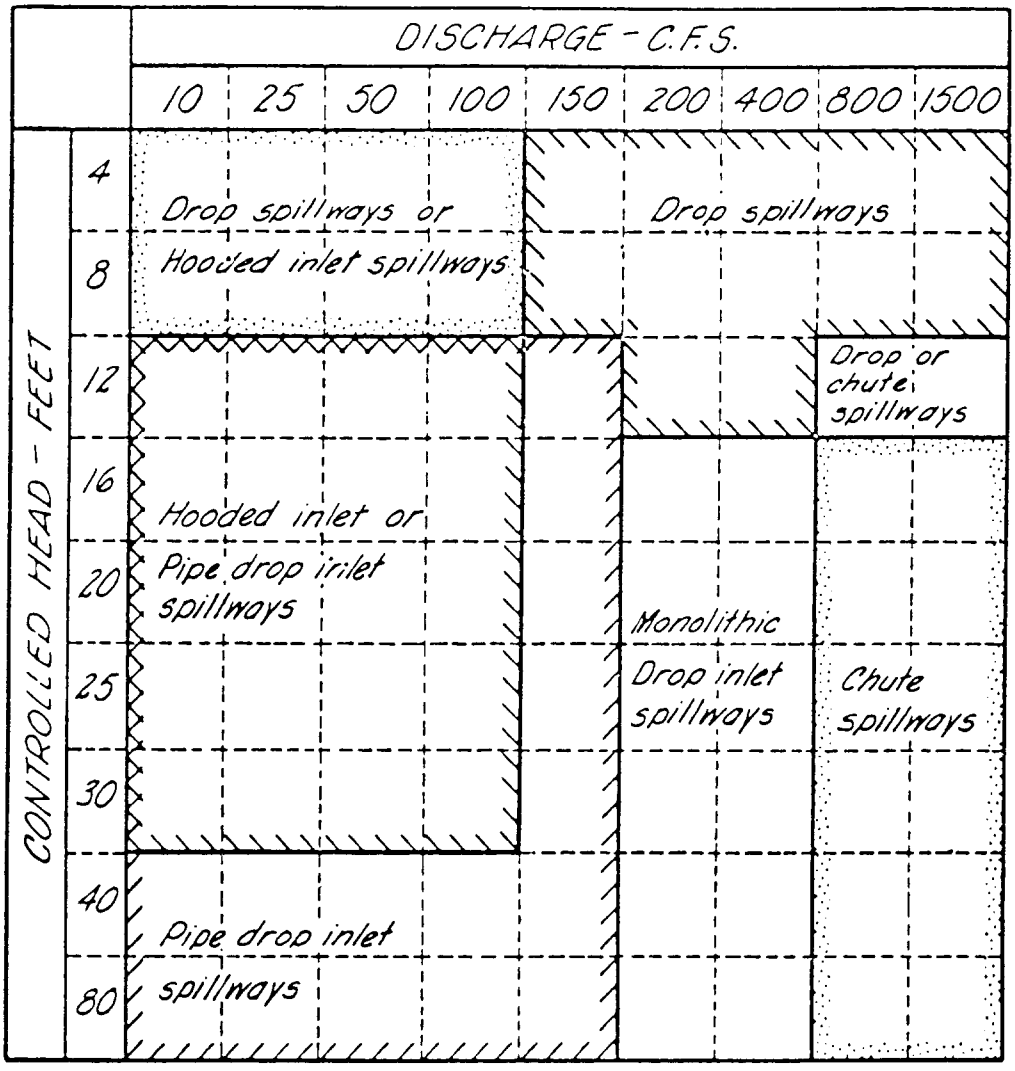
Note: h = total depth of weir, in feet (including freeboard)
c = net drop from crest to top of transverse sill, in feet
(For type B drops keep h÷F less than 0.75)

$$Q = \frac{3.1\ L h^{3/2}}{(1.10 + 0.01\ F)}$$

WEIR CAPACITY FOR STRAIGHT DROP SPILLWAYS

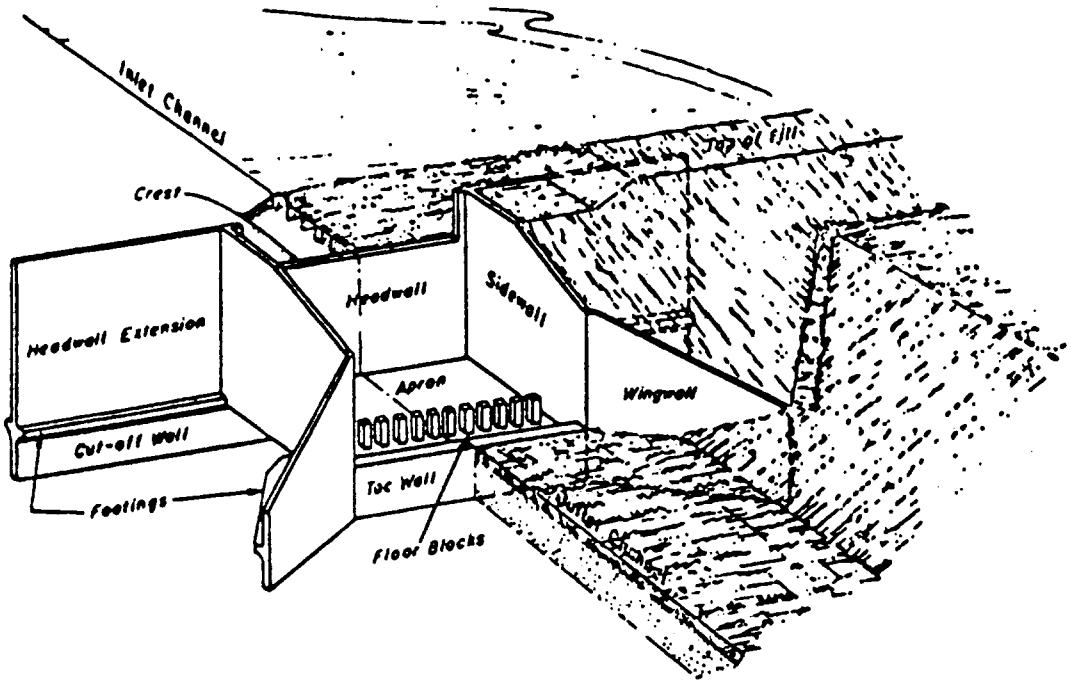
Figure 6-8.3

GENERAL GUIDE TO STRUCTURE SELECTION



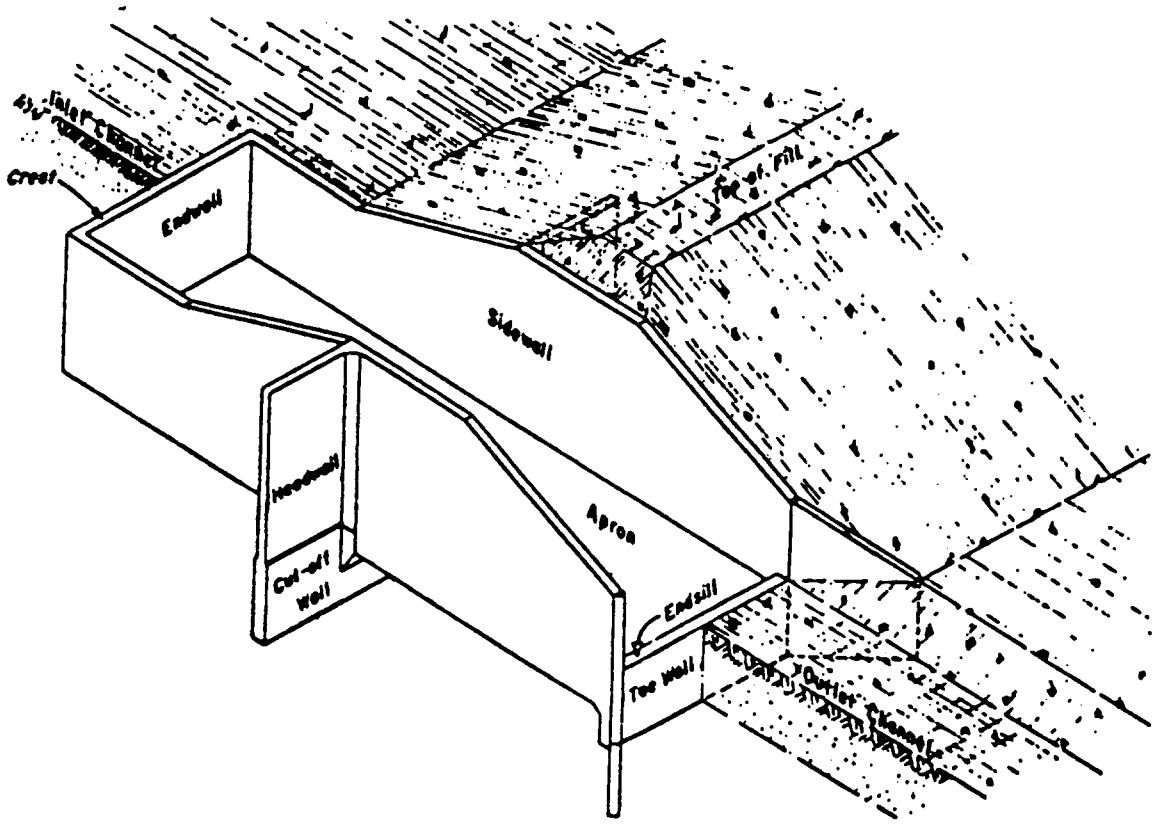
Note: Chart shows most economical structure as related to discharge and controlled head providing site conditions are adequate.

Figure 6-8.4



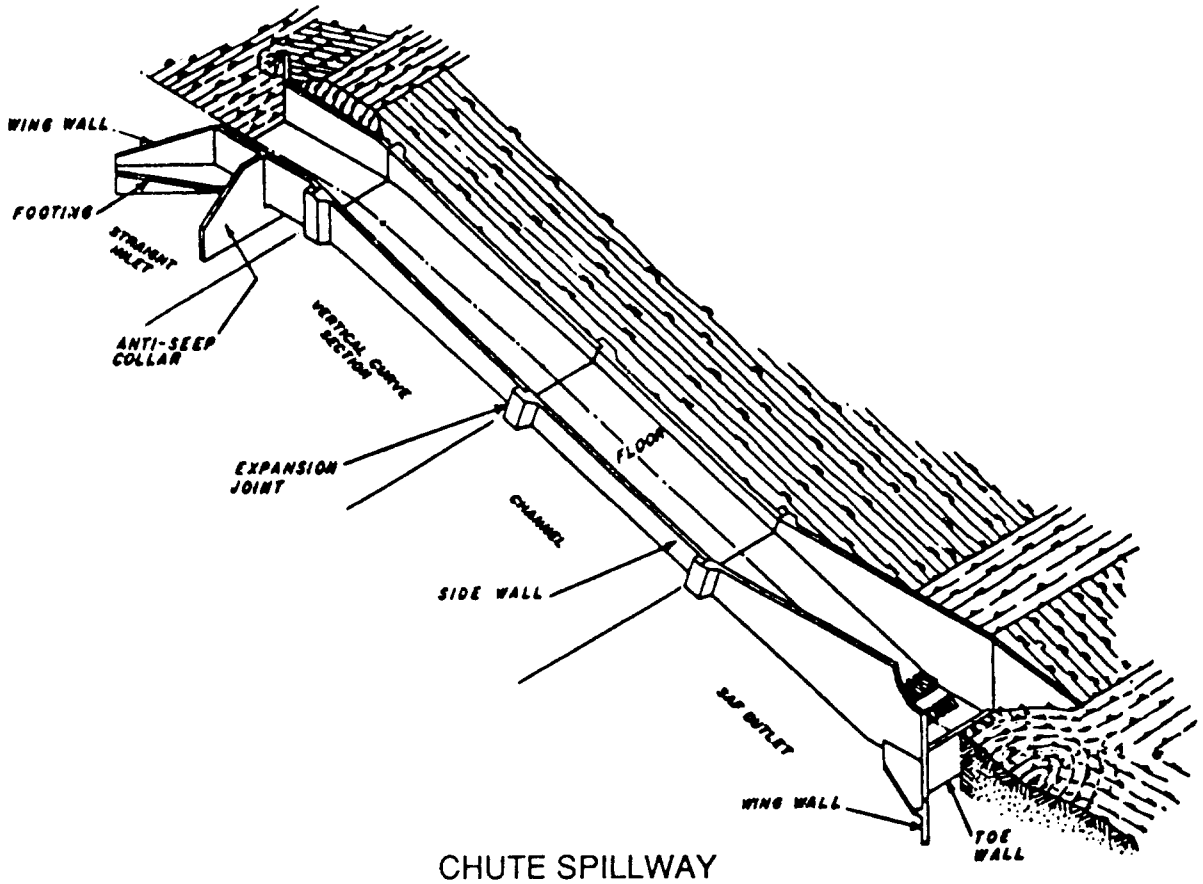
STRAIGHT DROP SPILLWAY

Figure 6-8.5



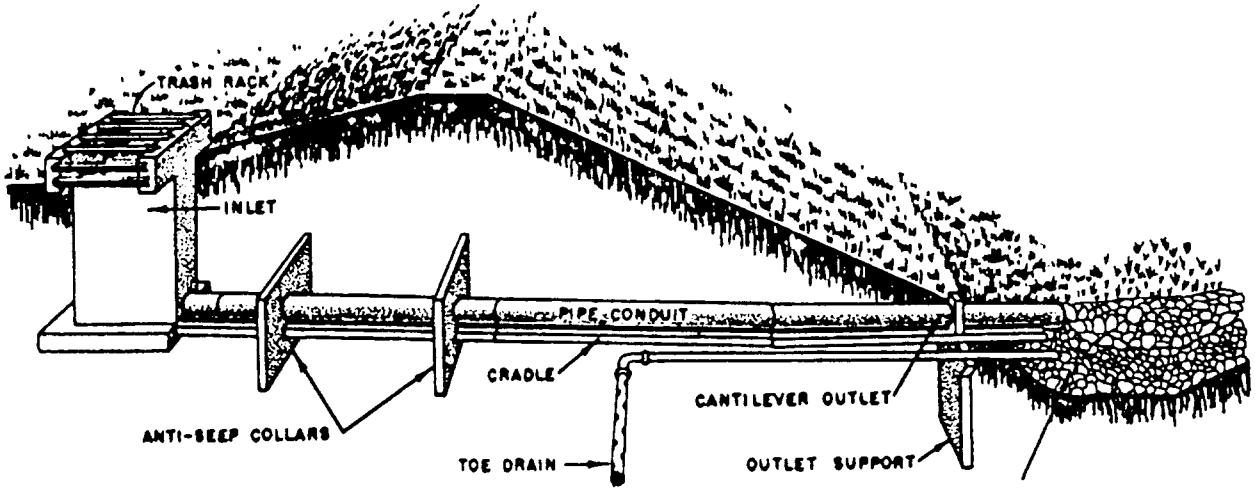
BOX INLET DROP SPILLWAY

Figure 6-8.6



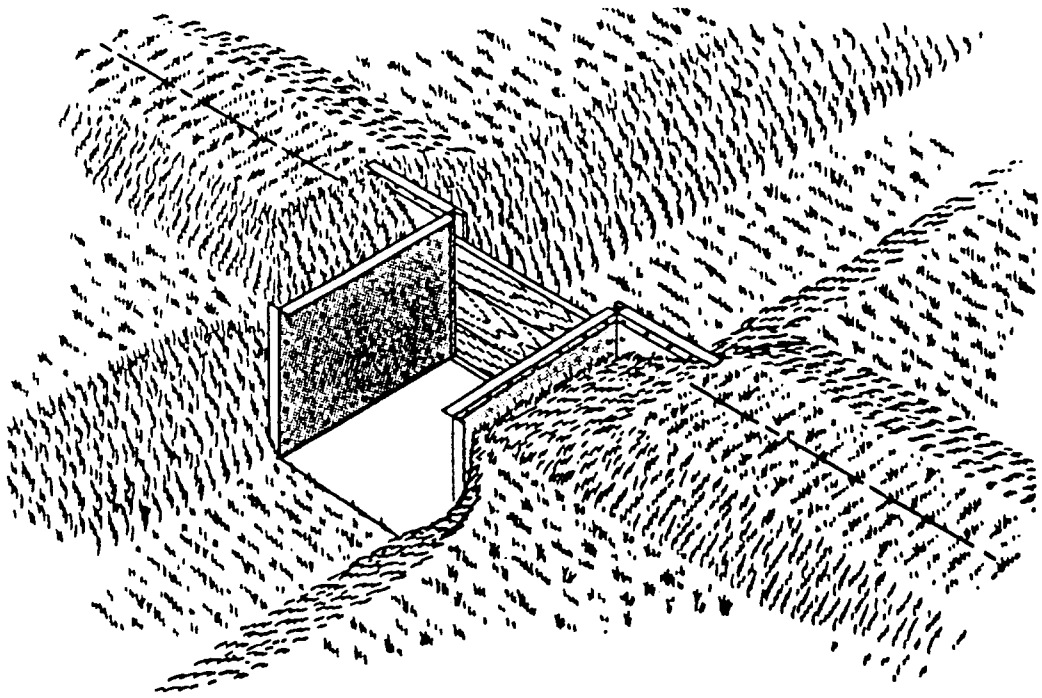
CHUTE SPILLWAY

Figure 6-8.7



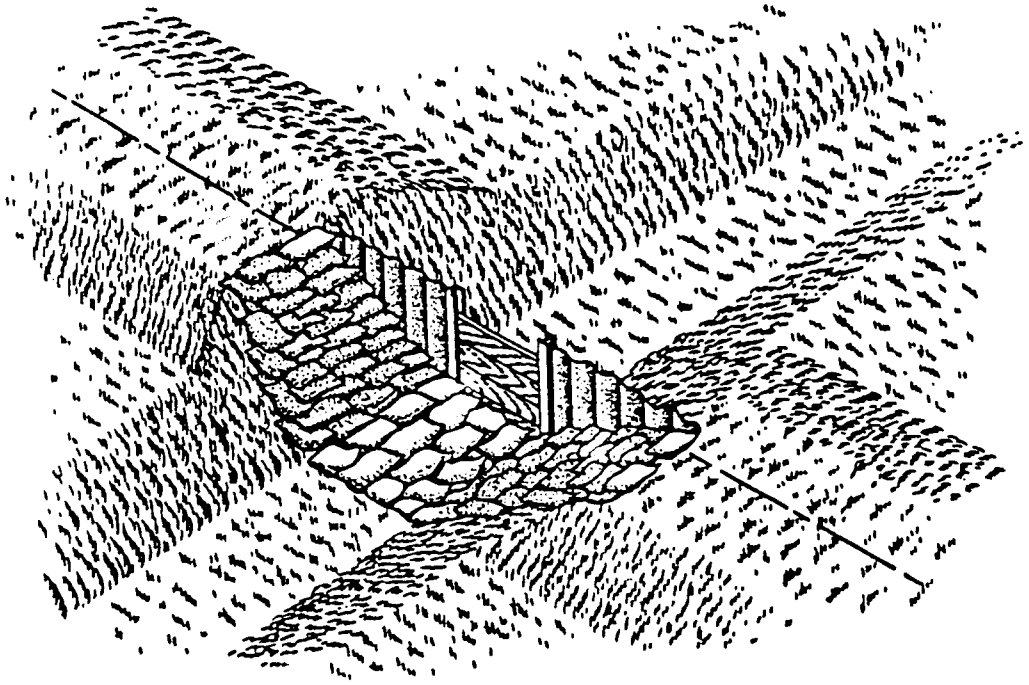
DROP INLET SPILLWAY

Figure 6-8.8



PREFABRICATED METAL STRUCTURE

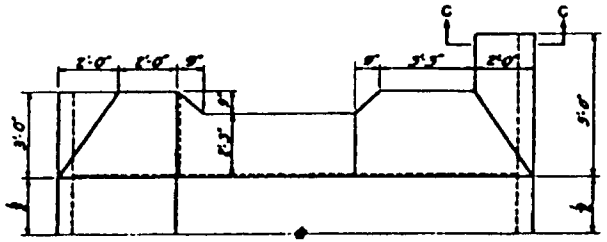
Figure 6-8.9

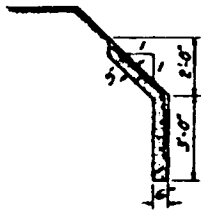


SHEET PILING HEADWALL WITH SAND-CEMENT BAG SIDEWALLS AND APRON.

Figure 6-8.10

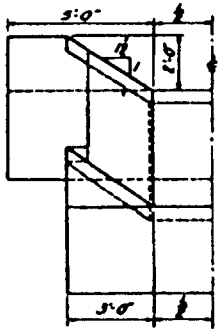
SMALL, LOW COST WATER CONTROL STRUCTURES

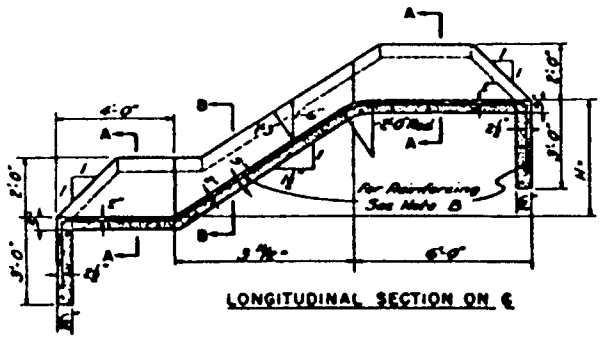


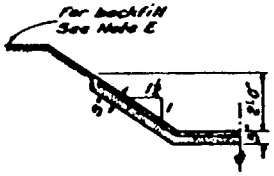


NOTES:-

A. Use 5 inch thickness of concrete throughout except as dimensioned otherwise.
B. Reinforcing as indicated shall be (1) 3/8"ϕ reinforcing steel 12" o.c. both ways; or (2) No.2 gauge welded wire fabric 6" o.c. both ways. (common designation 6x6 2/2). Reinforcing bars or mesh should be lapped one foot at all joints.
C. Spillways of this type shall be constructed on solid ground. Seep areas should be avoided or properly drained with a carefully constructed toe drainage system.
D. This spillway shall not be used as a part of a water impounding structure.
E. The disturbed area adjacent to the spillway shall be backfilled, compacted and sodded.
F. The length (L) of the spillway shall be limited by the amount of concrete that can be adequately mixed, placed and finished in one day's time with the labor and equipment available or a Max. L=8'-0"
G. The maximum "H" for this spillway is 5'-0"







STRUCTURAL DETAILS

Discharge Capacity of Spillway in c.f.s.				
Length of Crest (L) in feet	2	4	6	8
with no freeboard	30	45	60	75
with 6" freeboard	10	28	38	48

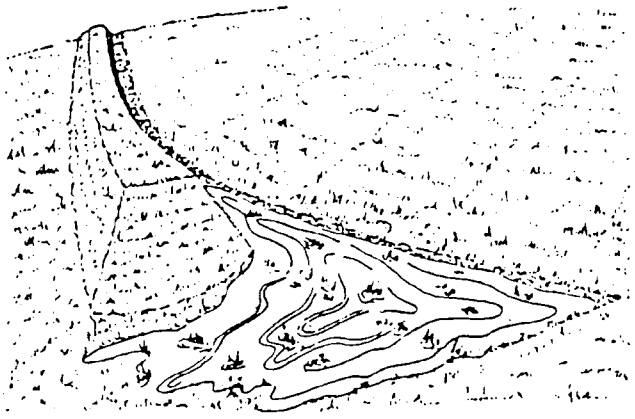
Concrete Volumes in Cubic Yards				
Head "H" Feet	Length of Crest (L) in feet			
	2'-0"	4'-0"	6'-0"	8'-0"
4'-0"	3.5	4.2	4.9	5.6
5'-0"	3.7	4.4	5.2	6.0

Typical Plan - Formless Concrete Chute

Figure 6-8.11

Level Spreader

Lv



DEFINITION

A storm flow outlet device constructed at zero grade across the slope whereby concentrated runoff may be discharged at non-erosive velocities onto undisturbed areas stabilized by existing vegetation.

PURPOSE

To dissipate storm flow energy at the outlet by converting storm runoff into sheet flow and to outlet it on to areas stabilized by existing vegetation without causing erosion.

CONDITIONS

Where sediment-free storm runoff is intercepted and diverted from graded areas onto undisturbed stabilized areas (i.e., at diversion outlets, etc.). This practice applies only in those situations where the spreader can be constructed on undisturbed soil and where the area directly below the level lip is stabilized by existing vegetation. The water must not be allowed to reconcentrate below the point of discharge.

DESIGN CRITERIA

Length

A specific design for level spreaders will not be required. However, spreader length will be determined by estimating 10-year 24-hour return frequency stormflows and selecting the appropriate length from the following table:

Designed Q10/24 (cfs)	Minimum Length ("L" in Feet)
up to 10	10
11 to 20	20
21 to 30	30
31 to 40	40
41 to 50	50

Outlets

Final discharge will be over the level lip onto an undisturbed stabilized area. The outlet shall be generally smooth to create uniform sheet flow.

CONSTRUCTION SPECIFICATIONS

The minimum acceptable width shall be 6 feet. The depth of the level spreader as measured from the lip shall be at least 6 inches and the depth shall be uniform across the entire length of the measure.

The grade of the channel for the last 15 feet of the dike or diversion entering the level spreader shall be less than or equal to 1%.

Construct level lip on zero percent grade to insure uniform spreading of storm runoff (converting channel flow to sheet flow)

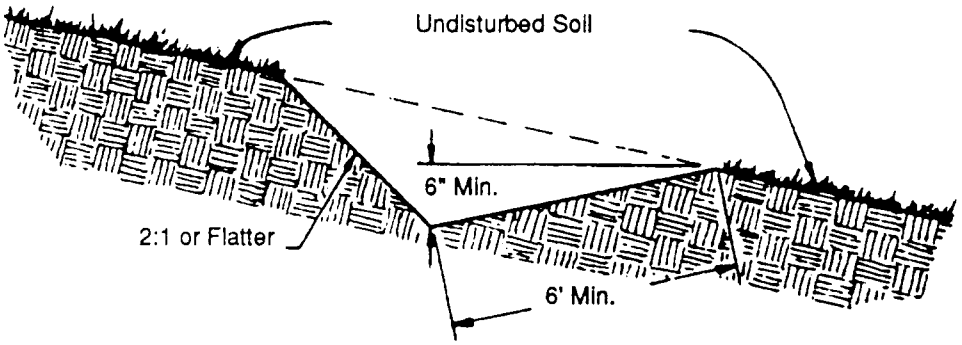
Level spreaders must be constructed on *undisturbed soil* (not on fill).

Entrance to spreader must be graded in a manner to insure that runoff enters directly onto the zero percent graded channel.

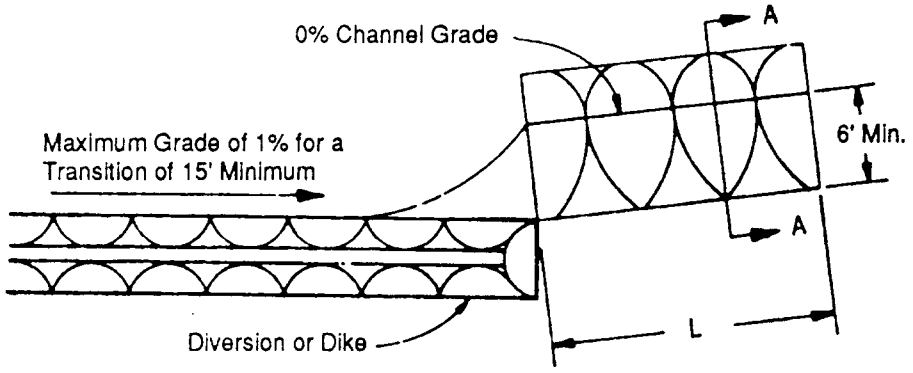
Storm runoff converted to sheet flow must outlet onto undisturbed stabilized areas.

Periodic inspection and maintenance must be provided to insure the intended purpose is accomplished.

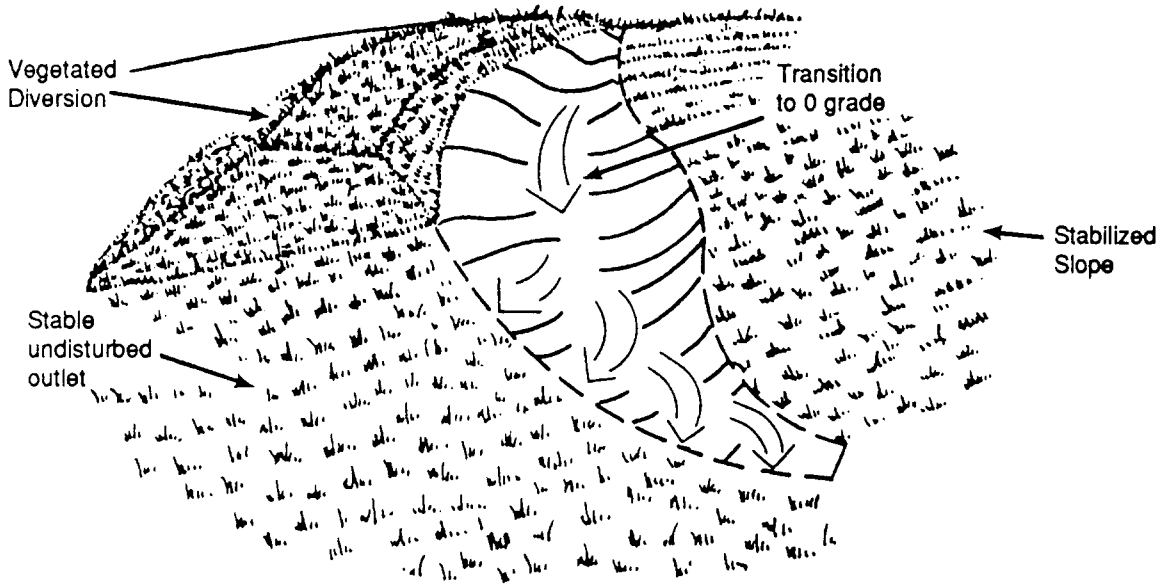
All disturbed areas shall be vegetated immediately after construction is completed.



SECTION A-A



PLAN



ISOMETRIC VIEW - (Not to Scale)

LEVEL SPREADER

Figure 6-9.1

Rock Filter Dam

Rd

DEFINITION

Permanent or temporary stone filter dam installed across small streams or drainageways.

PURPOSE

This structure is installed to serve as a sediment filtering device in drainageways. In some cases, it may also reduce the velocity of stormwater flow through a channel. This structure is not intended to substantially impound water. Before structures of any kind are installed in flowing streams, the appropriate agencies and local officials should be contacted.

CONDITIONS

This practice is applicable for use in small channels which drain 1 square mile or less. It must be used in conjunction with other appropriate sediment control measures, to reduce the amount of sediment reaching the channel. Specific applications include:

1. Shall be used as additional sediment control measure below construction projects such as culvert installations, dam construction, or any project that may involve grading activity directly in a stream.
2. Shall be used at the upstream end of ponds or lakes to trap incoming sediment loads.

DESIGN CRITERIA

Formal design is not required, but it is recommended that a qualified engineer be consulted before a structure of any kind is installed in a flowing stream. (Refer to Figure 6-10.1)

The following standards shall be followed:

Drainage areas: shall not exceed 1 square mile or 640 acres.

Height: should not be higher than the channel banks or the anticipated 10-year storm level within the channel. The center of the rock dam should be at least 6 inches lower than the outer edges of the dam at the channel banks.

Side slopes: 2:1 or flatter.

Location: should be located so that it will not cause water to back up on upstream adjacent property. Dam height should not exceed elevation of upstream property line.

Rock size: shall be determined by the design criteria established in the riprap section in this manual, Appendix C . The rock dam can be faced with smaller stone on the upstream side for additional filtering effect.

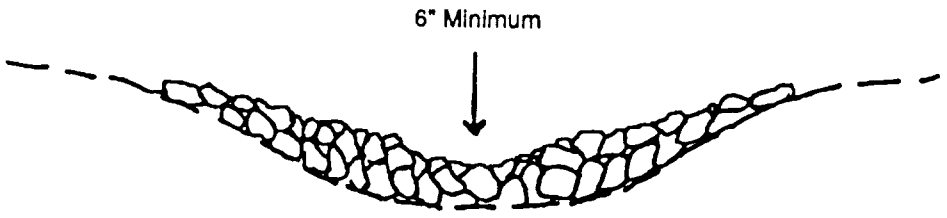
Top width: should be no less than 6 feet.

CONSTRUCTION SPECIFICATIONS

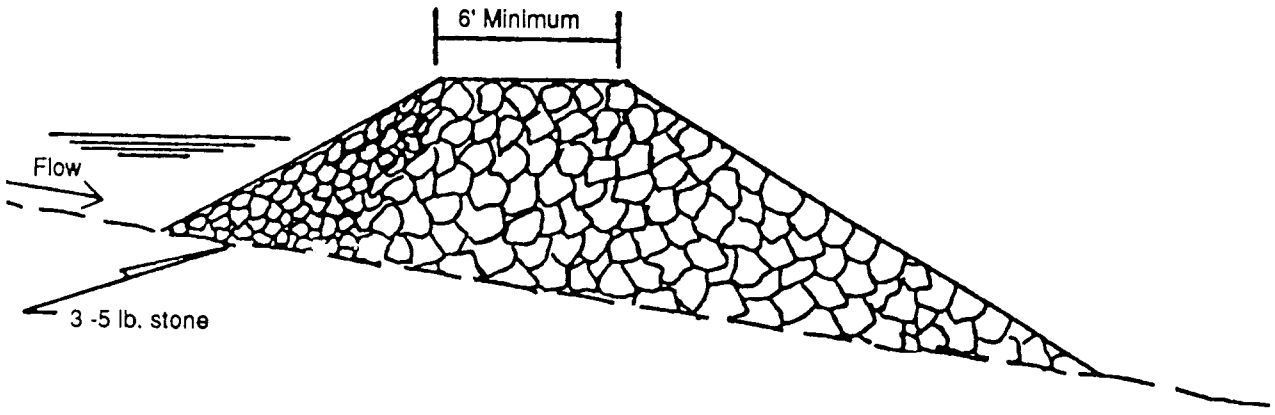
Mechanical or hand placement will be required to insure that rock dam extends completely across channel and securely ties into both channel banks. The center of the dam must be no less than six inches lower than the sides, to serve as a type of weir. Gabions can be installed to serve as rock filter dams, but should follow recommended sizing and installation specifications. (Refer to Ga. standard for "GABION" in this manual.)

Maintenance

Rock dams should be removed at the completion of their useful life. Periodic inspection and required maintenance must be provided. Sediment should be removed when it reaches a depth of one-half of the original height of the dam.



NOTE: Sediment Trap is to be cleaned out when volume becomes half full.



NOTE: Rock size determined according to specifications set forth in Appendix C.

ROCK DAM FOR SEDIMENT CONTROL

Figure 6-10.1

Retaining Wall

Re

DEFINITION

A constructed wall of one or more of the following: concrete masonry, reinforced concrete cribbing, treated timbers, steel pilings, gabions, stone drywall, rock riprap, etc.

PURPOSE

To assist in the stabilization of cut or fill slopes where stable slopes are not attainable without the use of the wall.

CONDITIONS

Use in conjunction with cut or fill slopes which, because of space limitations or unstable material, do not allow the stable slope criteria listed above, e.g., cuts into steep hillsides on small lots or cuts into hillsides behind shopping centers to provide loading space.

DESIGN CRITERIA

General

The design of a retaining wall is a complicated process. Many factors must be taken into account such as: stresses and forces outside and within the wall, allowable height, minimum thickness. Other considerations are: foundation design with respect to loadings, bearing values of soils, footing dimensions. Additional design factors are: safety hazards, subsurface and surface drainage and appearance.

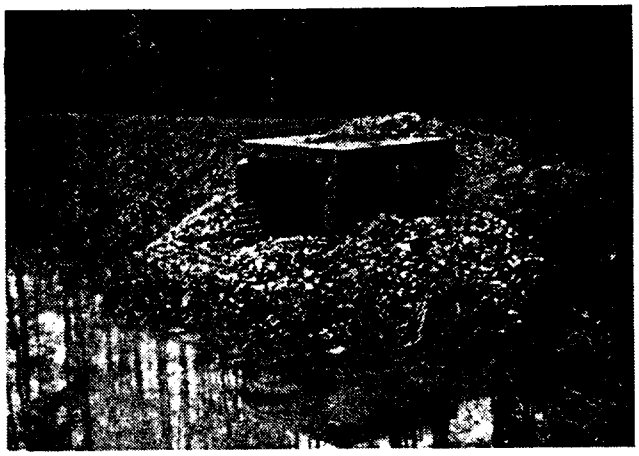
Each situation requires a *specific design* which is within the capabilities of the design engineer and architect.

Consideration should be given to all of the alternative methods with regard to construction of the wall. Some methods are:

1. concrete masonry
2. concrete cribbing
3. gabions
4. steel piling
5. stone drywall
6. rock riprap, etc.
7. treated timbers.

Retrofitting

Rt



DEFINITION

A device or structure placed in front of a permanent stormwater detention pond outlet structure to serve as a temporary sediment filter.

PURPOSE

This structure allows permanent stormwater detention basins to function as temporary sediment retention basins for land-disturbing projects.

CONDITIONS

This standard applies under the following conditions:

1. Cannot be used in detention basins on live streams or in basins with a total contributing drainage area of 100 acres or more.
2. Can only be used in detention basins large enough to store 67 cu. yds. sediment per acre of disturbed area in the project. Required sediment storage may be obtained by excavating in front of the retrofitted outlet structure.
3. Shall be considered a temporary structure and will be removed as soon as project is completed. All accumulated sediment will be removed from the detention pond basin.

DESIGN CRITERIA

1. The height of the retrofit should be approximately one-half the height of the stormwater management outlet structure.
2. The required sediment storage volume shall be achieved by either excavating the basin or raising the outlet structure to achieve 67 cu. yds. of sediment storage. This storage volume is exclusive of stormwater storage requirements. It is recommended that the sediment storage volume be based on total drainage area when possible. Remove sediment when the basin is one-third full.
3. For effective trapping efficiency, the sediment delivery inlets should be at the upper end of the basin.
4. For effective trapping efficiency, the length-width ratio of the basin shall be at least 2:1. The flow length may be increased with the use of baffle walls installed within the basin.
5. Drawings and computations shall be submitted similar to those required for temporary sediment basin Sd3.

CONSTRUCTION SPECIFICATIONS

The following types of structures are acceptable under the designated conditions:

1. Perforated half-round pipe with stone filter (See Figure 6-12.1).
   a) Diameter of half-round pipe should be 1.5 times the diameter of the principal pipe outlet or wider than the greatest width of the concrete weir.
   b) Perforations and stone sizes are shown in Figure 6-12.1.
   c) Shall be fixed by specified means (bolts, etc) to concrete outlet structure, but never used on exposed pipe end or winged headwall (See Figure 6-12.1).
   d) Should be used only in detention ponds with less than 30 acre total drainage area.
2. Slotted board dam with stone (See Figure 6-12.3).
   a) Can be used with open end pipe outlets, winged headwalls, or concrete weir outlets.
   b) Should be installed with minimum size 4x4" posts.
   c) Boards should have 0.5-1.0 inch spaces between them.
   d) Minimum size 3-5 inch stone filter shall be

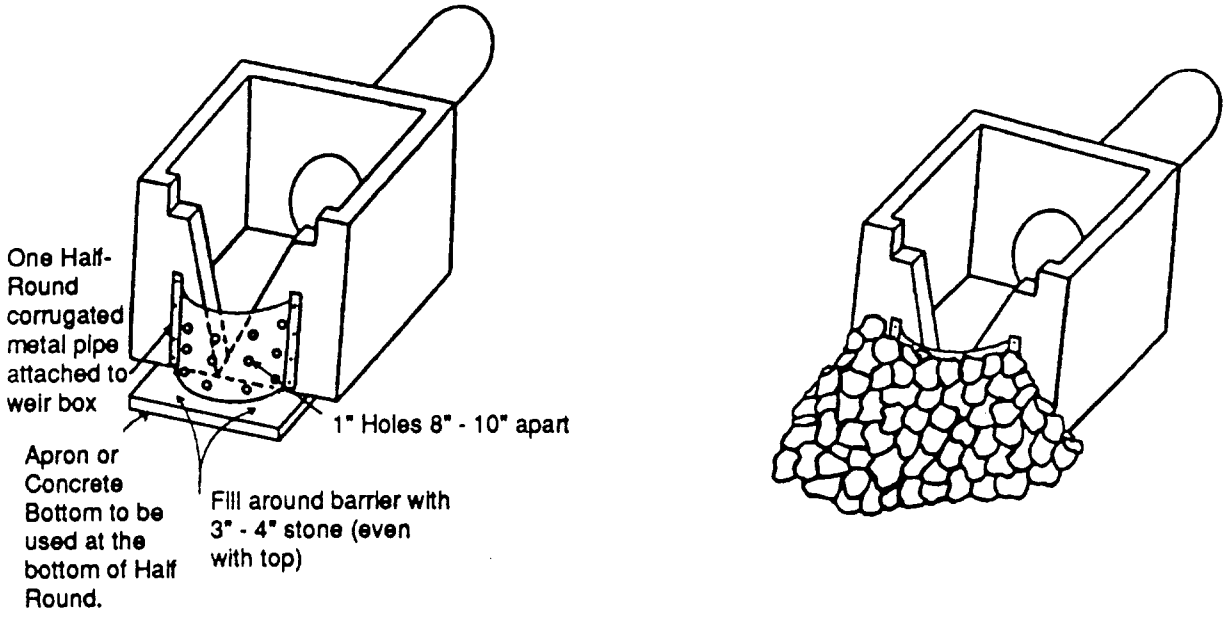
installed around the upstream side of the board dam.

e) Can be used in detention ponds with drainage areas up to 100 acres.

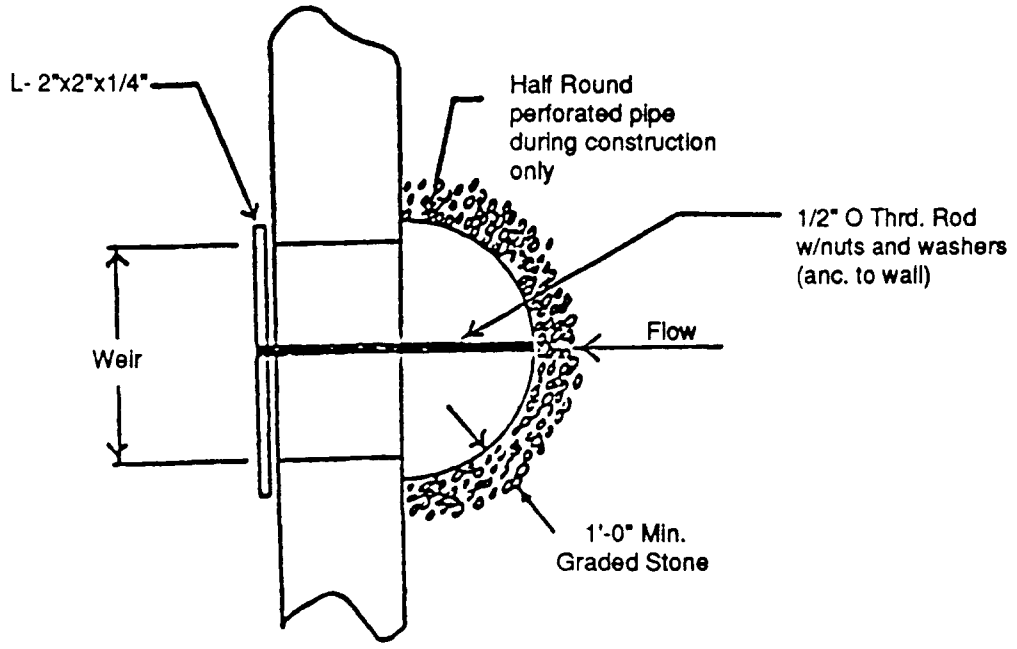
3. Stone filter rings (See Figure 6-12.2).
   a) Can be used in conjunction with half-rounds or board dams, as additional sediment filtering device.
   b) For pipe diameters larger than 12 inches, stone size should be a minimum 10-15 inch stone, faced with smaller filter stone on the upstream side, if necessary.
4. All disturbed areas shall be vegetated immediately after construction with perennial vegetation.

MAINTENANCE

All types of retrofit structures must be kept clear of trash and debris. This will require continuous monitoring and maintenance, which includes sediment removal when one-third full. Structures are temporary and should be removed when the land-disturbing project has been re-stabilized.



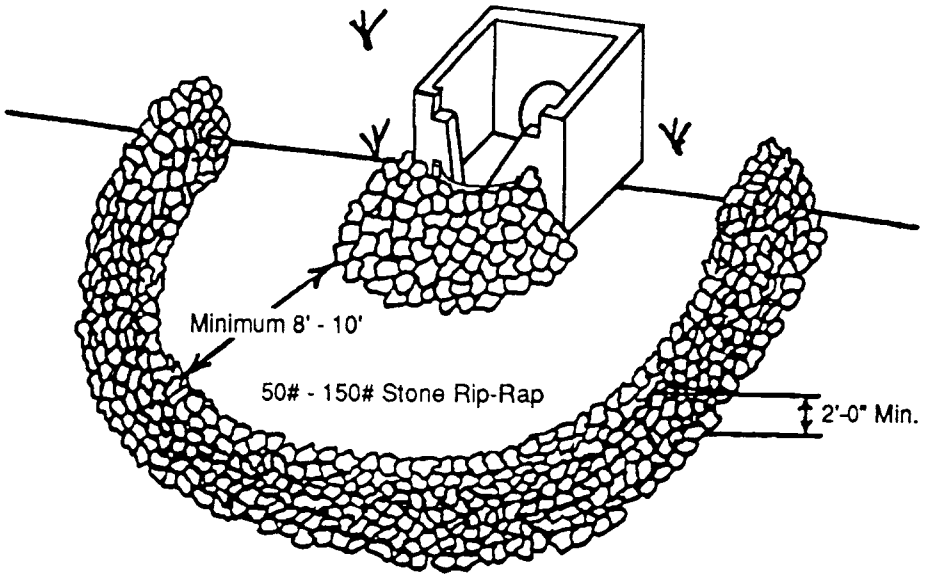
ISOMETRICS



PLAN

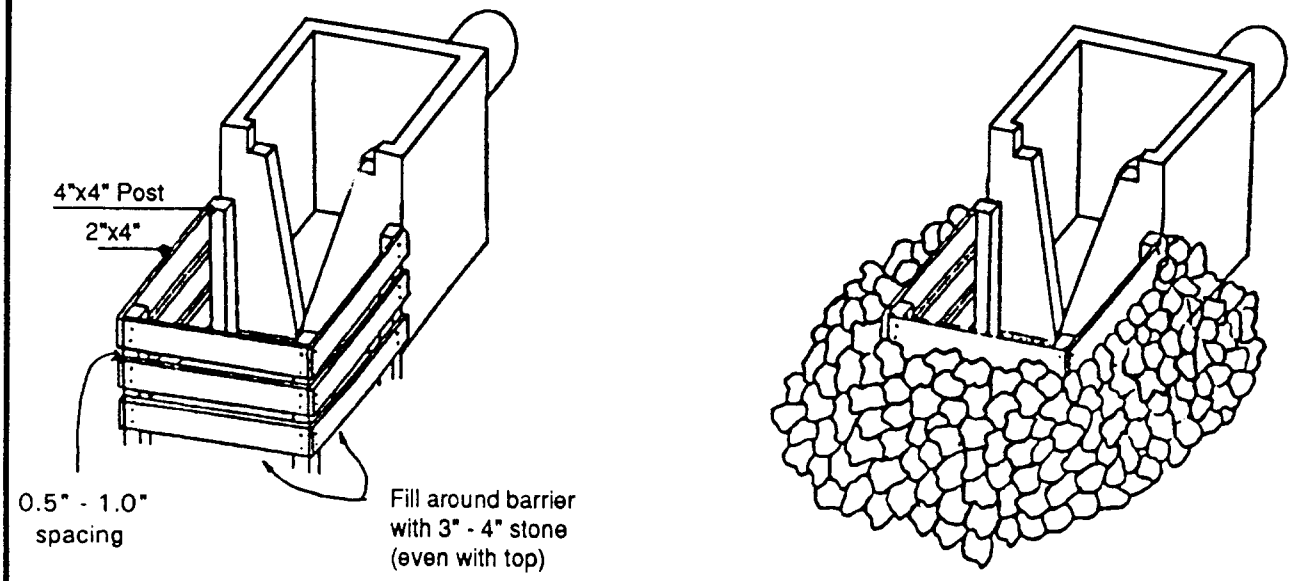
PERFORATED HALF-ROUND PIPE WITH STONE FILTER

Figure 6-12.1



STONE FILTER RING

Figure 6-12.2

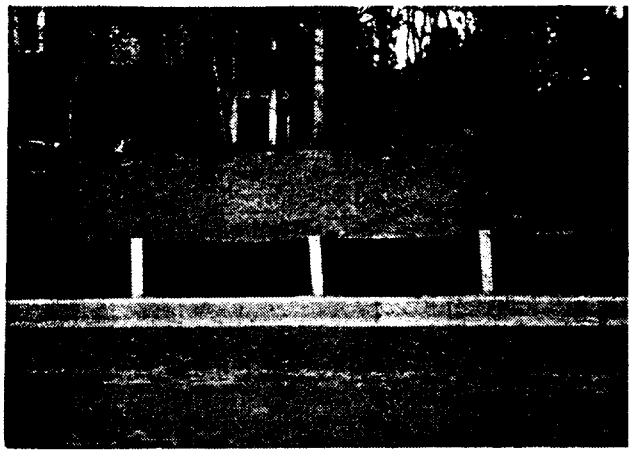


SLOTTED BOARD DAM WITH STONE FILTER

Figure 6-12.3

Sediment Barrier

Sd1



DEFINITION

Sediment barriers are temporary structures typically constructed of silt fence supported by steel or wood posts. Other types of barriers may include sandbags, straw bales, brush piles and other filtering material.

PURPOSE

To prevent sediment carried by sheet flow from leaving the site and entering natural drainage ways or storm drainage system by slowing storm water runoff and causing the deposition of sediment at the structure.

CONDITIONS

Below small disturbed areas less than 1/4 acre per 100 ft. of fence.

Where runoff can be stored behind the sediment fence without damaging the fence or the submerged area behind the fence.

Do not install sediment fences across streams, ditches, or waterways.

DESIGN CRITERIA

Ensure that the drainage area is no greater than 1/4 acre per 100 ft. of non-reinforced fence. For wire reinforced fence, the drainage area should not exceed 1/ 2 acre.

Make the fence stable for the 10-year, 24-hour storm runoff.

Where all runoff is to be stored behind the fence, ensure that the maximum slope length behind a sediment fence does not exceed the specifications shown in Table 6-13.1.

If non-erosive outlets are provided, slope length may be increased beyond that shown in Table 6-13.1, but runoff from the area should be determined and bypass capacity and erosion potential along the fence must be checked. The velocity of the flow at the outlet or along the fence should be in keeping with Table 6-13.1.

Table 6-13.1

	Slope	Slope Length (ft)
Maximum Slope Length and Slope for which Sediment Fence is Applicable	<2%	100
	2 to 5%	75
	5 to 10%	50
	10 to 20%	25
	>20%	15

Provide a riprap splash pad or other outlet protection device for any point where flow may over top the sediment fence such as natural depressions or swales. Ensure that the maximum height of the fence at a protected, reinforced outlet does not exceed 1 ft. and that support post spacing does not exceed 4 ft.

The design life of a synthetic sediment fence should be 6 months. Burlap is only acceptable for periods up to 60 days.

CONSTRUCTION SPECIFICATIONS

Sandbags (if approved by local issuing authority)

Should be installed so that flow under or between bags is minimal. Anchoring with steel rods may be required if structure height exceeds two bags.

Hay or Straw Bales (if approved by local issuing authority)

Bales will be placed in a single row, lengthwise, on

the contour and embedded in the soil to a depth of 4 inches. Bales must be securely anchored in place by stakes or bars driven through the bales or by other acceptable means to prevent displacement. (See Figures 6-13.1 and 6-13.2)

Brush (only during timber clearing operations)

Brush, obtained from clearing operations may be piled in a row along the perimeter of land disturbing activities. Brush should be windrowed on the contour as nearly as possible.

Brush may require compaction. Construction equipment may be utilized to accomplish this purpose.

If a greater filtering capacity is required, a commercially available filtering fabric may be placed on the construction side of the brush barrier. The lower edge of the fabric must be buried in a trench 4" to 6" deep. The upper edge must be stapled, tied or otherwise fastened to the brush barrier.

Consideration should be given to the removal of brush barriers after the area is stabilized if the barrier could be considered a "vision pollutant."

Silt Fence

A silt fence is specifically designed to allow water to pass through while retaining sediment on site.

Silt Fence Specifications

Two widths of silt fence are available, Type A (36" height) and Type B (22" height). In order to determine which to use, the project duration, slope gradient, and slope length must be known (See Table 6-13.2). Approved silt fence fabrics are listed in the Georgia Department of Transportation list #36. The manufacturer shall have either an approved color mark yarn in the fabric or label the fabricated silt fence with both the manufacturer and fabric name every 100 feet.

All silt fence must meet the minimum standards set forth in Section 171-Temporary Silt Fence, of the Department of Transportation, State of Georgia, Standard Specification, current edition. See Table 6-13.5 for current Georgia DOT silt fence specifications.

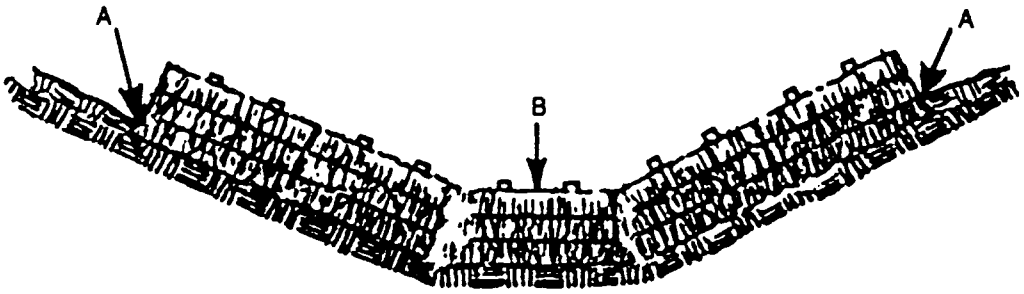
Silt Fence Installation

The contractor shall install the temporary silt fence according to this specification, as shown on the plans or as directed by the engineer. For installation of Type A and B fabric, see Figures 6-13.3 and 6-13.4 respectively.

Post installation shall start at the center of the low point (if applicable) with remaining posts spaced 6 feet apart. For post size requirements of Type A and B fabric, see Table 6-13.3. Fasteners for wood posts are listed in Table 6-13.4.

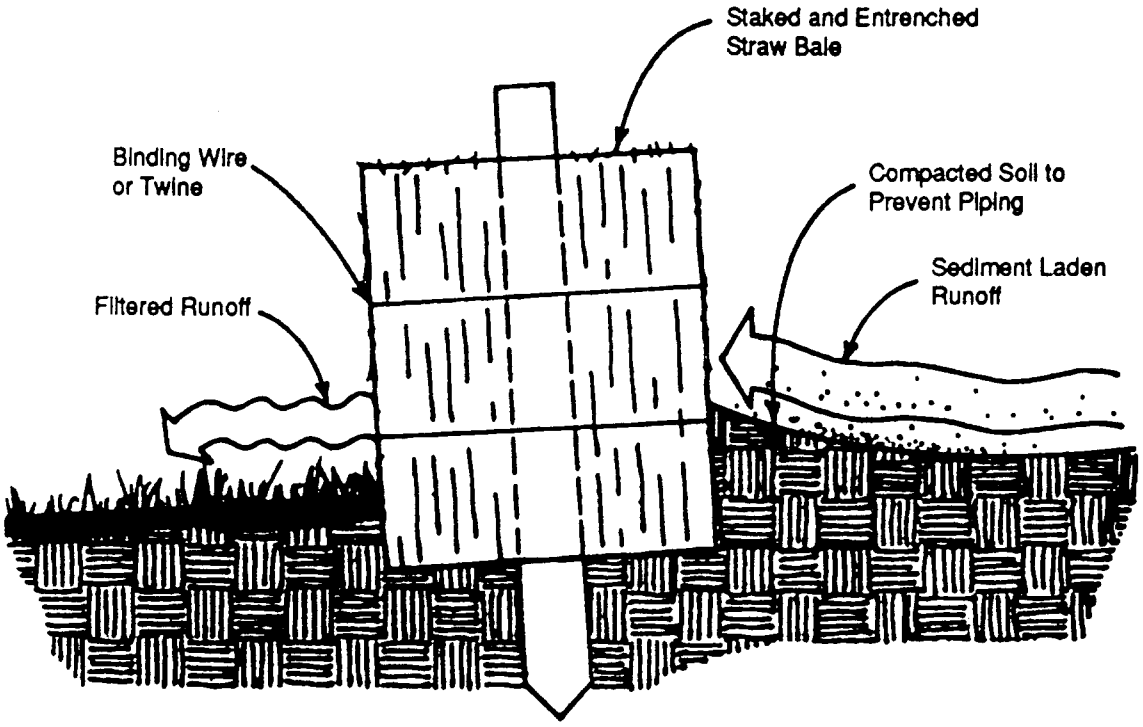
Maintenance and Removal

The contractor shall maintain the silt fence until the project is vegetated or accepted. Filter fabric shall be replaced whenever it has deteriorated to such an extent that it reduces the effectiveness of the fabric.



Points A should be higher than point B

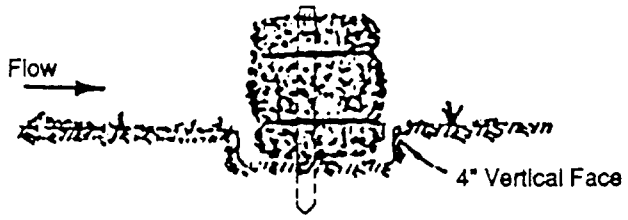
PROPER PLACEMENT OF STRAW BALE BARRIER IN DRAINAGE WAY



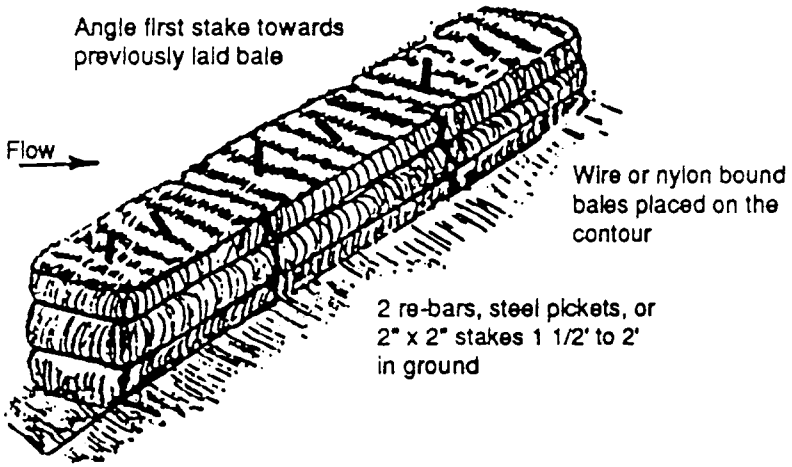
Note: Embed hay bales a minimum of 4 inches.

CROSS-SECTION OF A PROPERLY INSTALLED STRAW BALE

Figure 6-13.1



EMBEDDING DETAIL



ANCHORING DETAIL

NOTE:

- Anchor and embed into soil to prevent washout or water working under barrier
- Repair or replacement must be made promptly as needed

STAKED HAYBALE BARRIERS

Figure 6-13.2

SILT FENCE TYPES

Table 6-13.2

Width of Fabric		Use
Type A (36")	1)	On developments where the life of the project is greater than or equal to 6 months.
	2)	Where the slope gradient is steeper than 3:1.
Type B (22")	1)	On projects, such as residential home sites or small commercial developments, where the life of the project is less than 6 months.
	2)	Where the slope gradient is less than or equal to 3:1.
Type C (36") with woven wire reinforcement	1)	Where fill slopes exceed a vertical height of 20 feet and the slope gradient is steeper than 3:1.

POST SIZE

Table 6-13.3

	Minimum Length	Type of Post	Size of Post
Type A	4'	Soft wood	3" dia. or 2x4
		Oak	1.5" x 1.5"
		Steel	1.3lb./ft. min.
Type B	3'	Soft wood	2" dia. or 2x2
		Oak	1" x 1"
		Steel	.75lb./ft. min.
Type C	4'	Steel	1.3lb./ft. min.

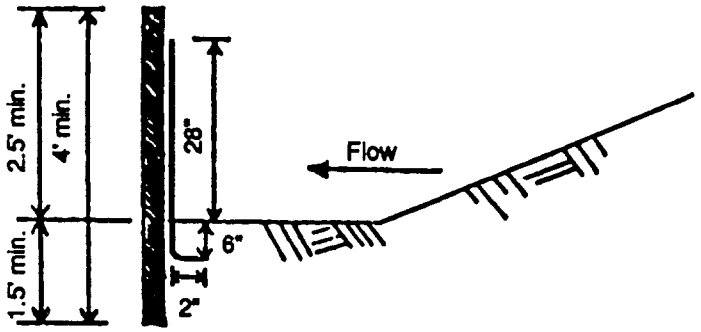
FASTENERS FOR WOOD POSTS

Table 6-13.4

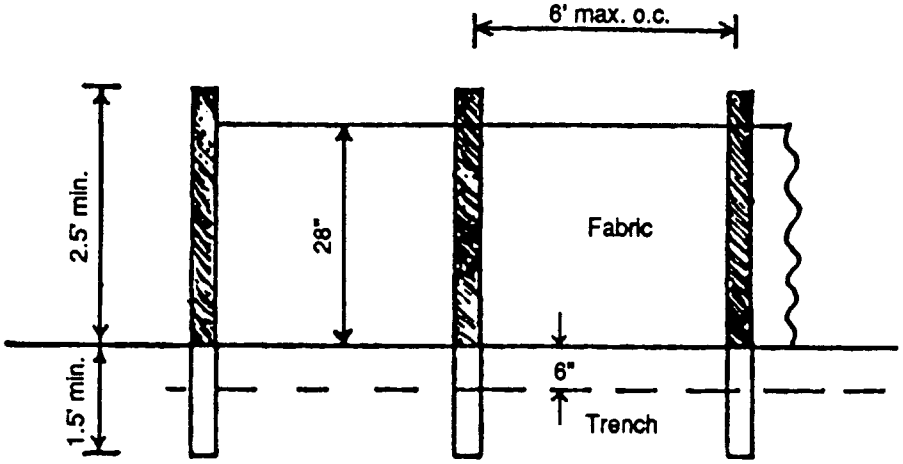
	Gauge	Crown	Legs	Staples/Post
Wire Staples	17 min.	3/4" wide	1/2" long	5 min.

	Gauge	Length	Button Heads	Nail/Post
Nails	14 min.	1"	3/4"	4 min.

Note: Filter fabric may also be attached to the post by wire, cord, and pockets.



SIDE VIEW

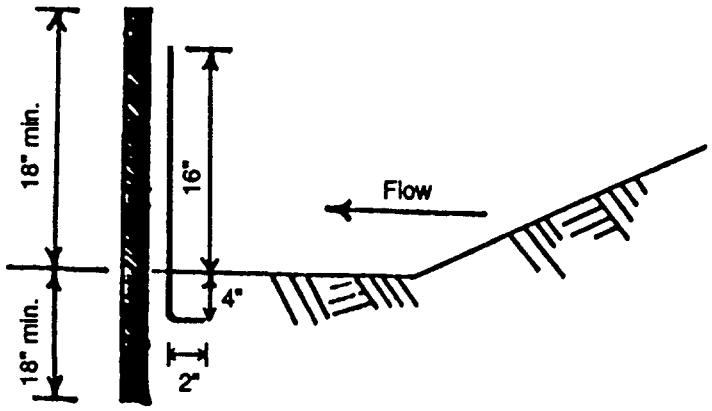


FRONT VIEW

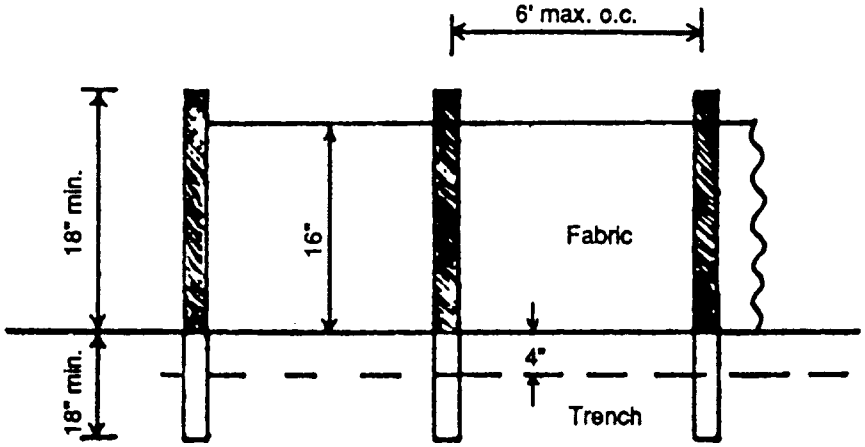
NOTE:
Use 36" D.O.T. approved fabric.
Use wood or steel posts.

SILT FENCE - TYPE A

Figure 6-13.3



SIDE VIEW

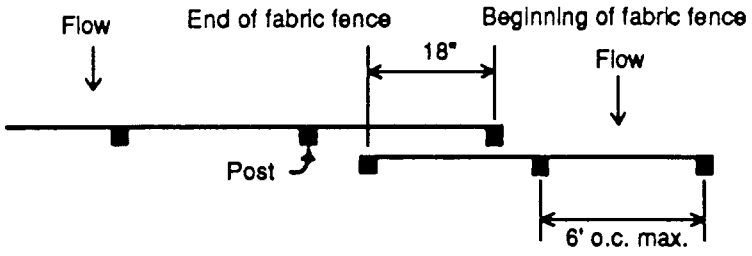


FRONT VIEW

NOTE:
Use 22" D.O.T. approved fabric.
Use wood or steel posts.

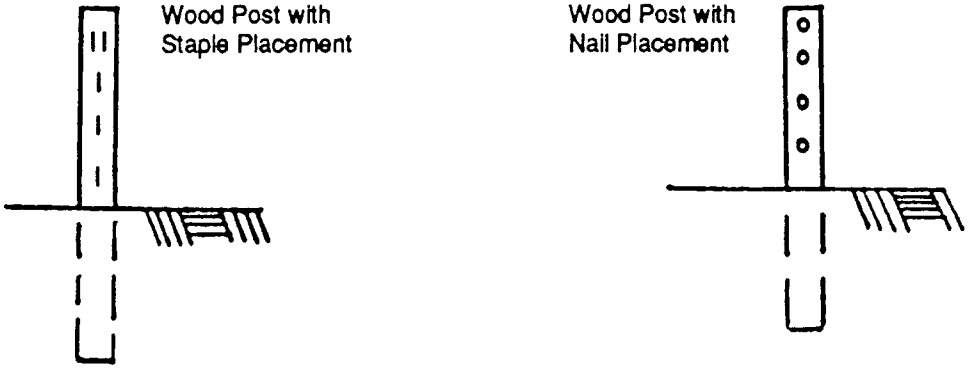
SILT FENCE - TYPE B

Figure 6-13.4



TOP VIEW - (Not to scale)

OVERLAP AT FABRIC ENDS



FRONT VIEWS

FASTENERS FOR TYPE A & TYPE B SILT FENCES

Figure 6-13.5

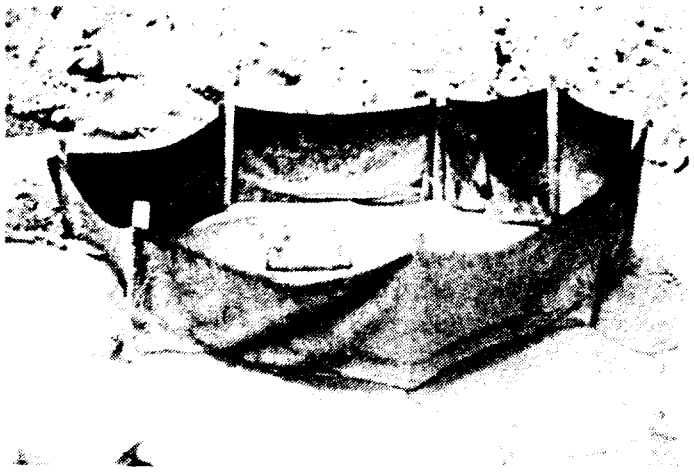
Table 6-13.5

TYPE FENCE	A	B	C
Tensile Strength (Lbs. Min.) (1) (ASTM D-4632)	Warp - 120 Fill - 100	Warp - 120 Fill - 100	Warp - 260 Fill - 180
Elongation (% Max.) (ASTM D-4632)	40	40	40
AOS (Apparent Opening Size) (Max. Sieve Size) (ASTM D-4751)	#30	#30	#30
Flow Rate (Gal/Min/Sq. Ft.) (GDT-87)	25	25	70
Ultraviolet Stability (2) (ASTM D-4632 after 300 hours weathering in accordance with ASTM D-4355)	80	80	80
Bursting Strength (PSI Min.) (ASTM D-3786 Diaphragm Bursting Strength Tester)	175	175	175
Minimum Fabric Width (Inches)	36	22	36

(1) Minimum roll average of five specimens.
(2) Percent of required initial minimum tensile strength.

Inlet Sediment Trap

Sd2



DEFINITION

A temporary protective device formed around a storm drain drop inlet to trap sediment.

PURPOSE

To prevent sediment from leaving the site, or from entering storm drainage systems, prior to permanent stabilization of the disturbed area.

CONDITIONS

Sediment traps should be installed at or around all storm drain drop inlets that receive runoff from disturbed areas.

Outlet protection should be installed below storm drain outlets to prevent scouring.

DESIGN CRITERIA

Many sediment filtering devices can be designed to serve as temporary sediment traps. A variety of examples are shown in the following figures. Where excavation is to be used, it shall be one in combination with a sediment filter such as stone or silt fence. All excavated sediment traps should provide a minimum of 1.5 feet of sediment storage. Sediment traps must be self-draining unless they are otherwise protected in an approved fashion that will not present a safety hazard.

For block and gravel drop inlet protection, Figure 6-14.4, lay one block on each side of the structure on its side in the bottom row to allow pool drainage. The foundation should be excavated at least 2 inches below the crest of the storm drain. Place the bottom row of blocks against the edge of the storm drain for lateral support and to avoid washouts when overflow occurs. If needed, give lateral support to subsequent rows by placing 2x4 wood studs through block openings. Carefully fit hardware cloth or comparable wire mesh with 1/2 inch openings over all block openings to hold gravel in place. Use clean gravel placed 2 inches below the top of the block on a 2:1 slope or flatter and smooth it to an even grade. DOT #57 washed stone is recommended.

For gravel drop inlet protection, Figure 6-14.5, stone and gravel are used. Keep the slope toward the inlet no steeper than 3 :1. Leave a minimum 1 foot wide level stone area between the structure and around the inlet to prevent gravel from entering the inlet. On the slope toward the inlet, use stone 3 inches in diameter and larger. On the slope away from the inlet, use 1/2 to 3/4 inch gravel (#57 washed stone) at a minimum thickness of 1 foot.

CONSTRUCTION SPECIFICATIONS

Sediment traps may be constructed on natural ground surface, on an excavated surface, or on machine compacted fill provided they have a non-erodible outlet.

MAINTENANCE

Inspect the trap after each rain and make repairs as needed. The traps must also be checked at the end of each working day and repaired or cleaned as necessary to insure that they will operate as intended.

Remove sediment as necessary to provide adequate storage volume for subsequent rains.

When the contributing drainage area has been adequately stabilized, remove all materials and any unstable soil, and either salvage it or dispose of it properly. Bring the disturbed area to proper grade, then smooth and compact it. Appropriately stabilize all bare areas around the inlet.

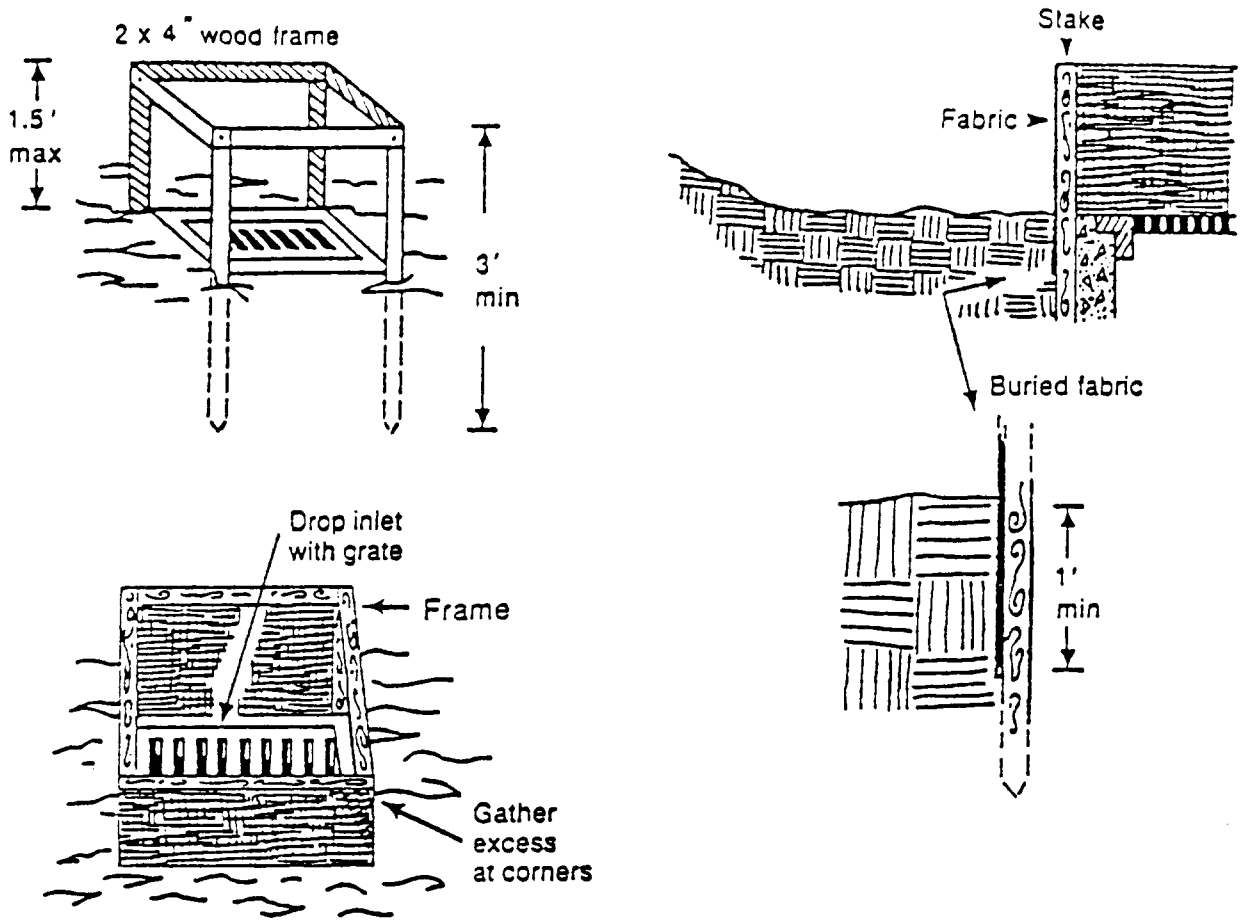


Figure 6-14.1 - Fabric and supporting frame for inlet protection.

1. For stakes, use 2 x 4 inch wood (preferred) or equivalent metal with a minimum length of 3 feet.

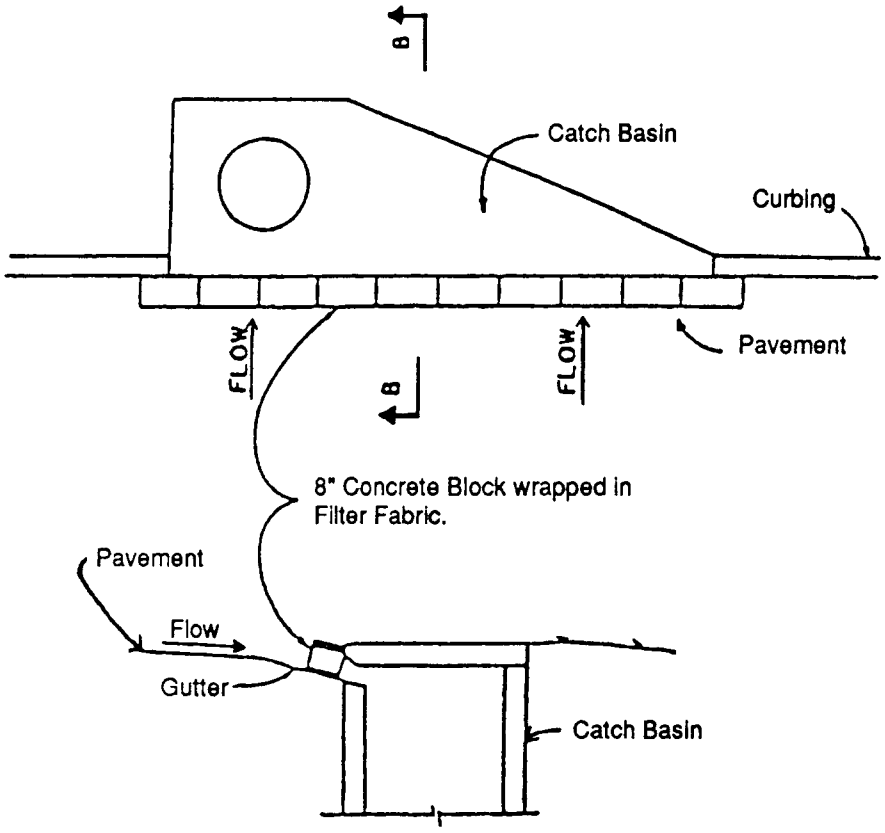
2. Space stakes evenly around the perimeter of the inlet a maximum of 3 feet apart, and securely drive them into the ground, approximately 18 inches deep.

3. To provide needed stability to the installation, frame with 2 x 4 inch wood strips around the crest of the overflow area at a maximum of 1.5 feet above the drop inlet crest.

4. Place the bottom 12 inches of the fabric in a trench and backfill the trench with at least 4 inches of crushed stone or 12 inches of compacted soil.

5. Fasten fabric securely to the stakes and frame. Joints must be overlapped to the next stake.

6. The top of the frame and fabric must be well below the ground elevation downslope from the drop inlet to keep runoff from bypassing the inlet. It may be necessary to build a temporary dike on the down slope side of the structure to prevent bypass flow.

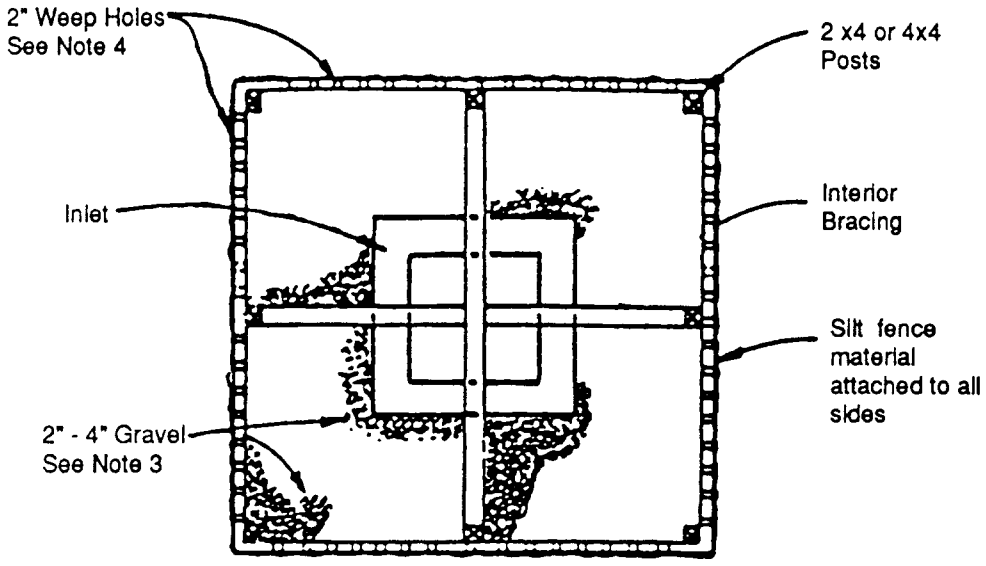


SECTION B-B

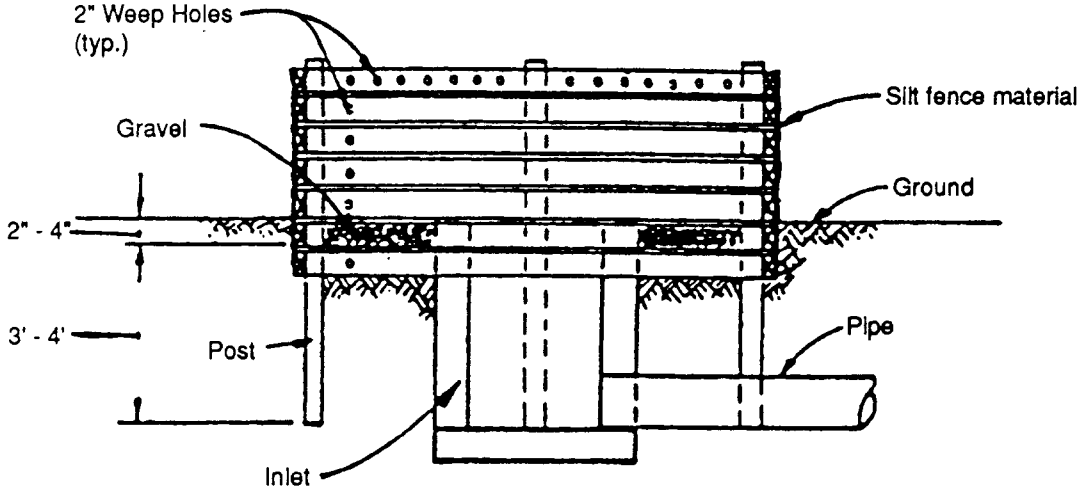
NOTE:
Install filter after any asphalt pavement installation.

CURB INLET FILTER
"PIGS IN BLANKET"

Figure 6-14.2



PLAN



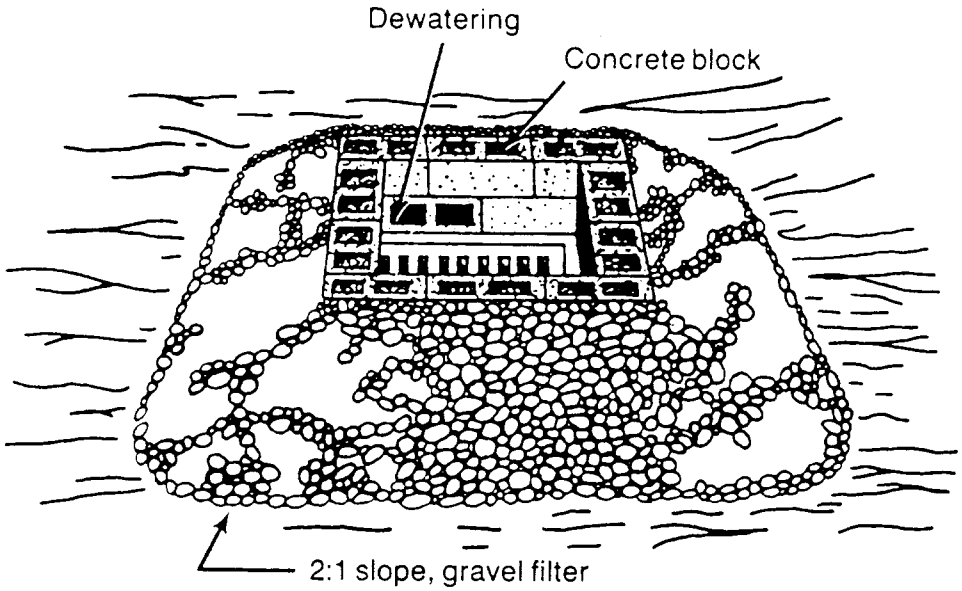
SIDE

NOTE:

1. The sediment box is to be made of 2"x4" boards spaced a maximum of 1" apart or of plywood with 2" weep holes.
2. Dimensions of the box will vary according to the size of the inlet and the depth of the basin.
3. Place gravel inside of the box all around the inlet to a depth of 2" to 4".
4. Space the weep holes approximately 6" o.c. vertical and 6" o.c. horizontal where plywood is used.

BAFFLE BOX

Figure 6-14.3



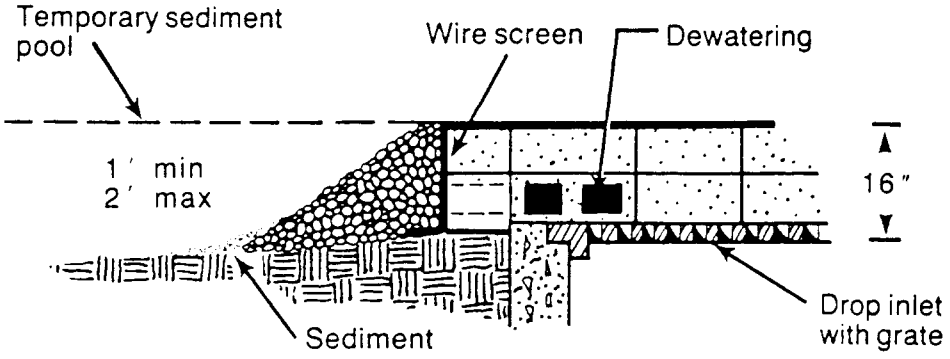


Figure 6-14.4 Block and gravel drop inlet protection

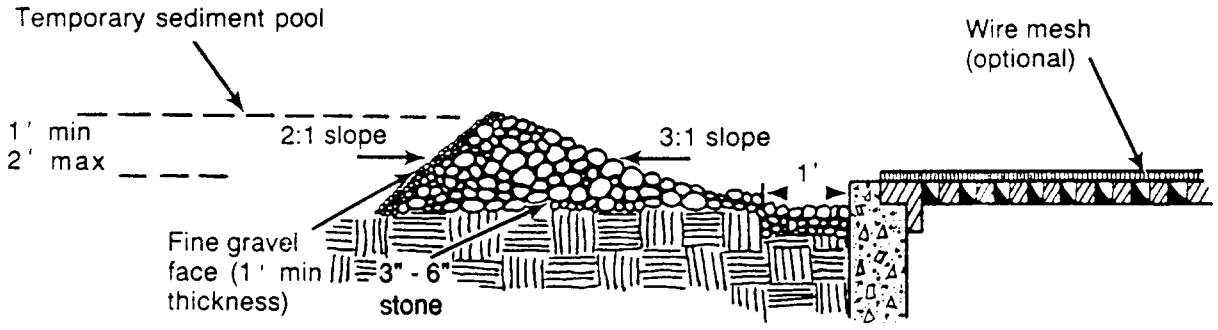


Figure 6-14.5 Gravel drop inlet protection (gravel donut)

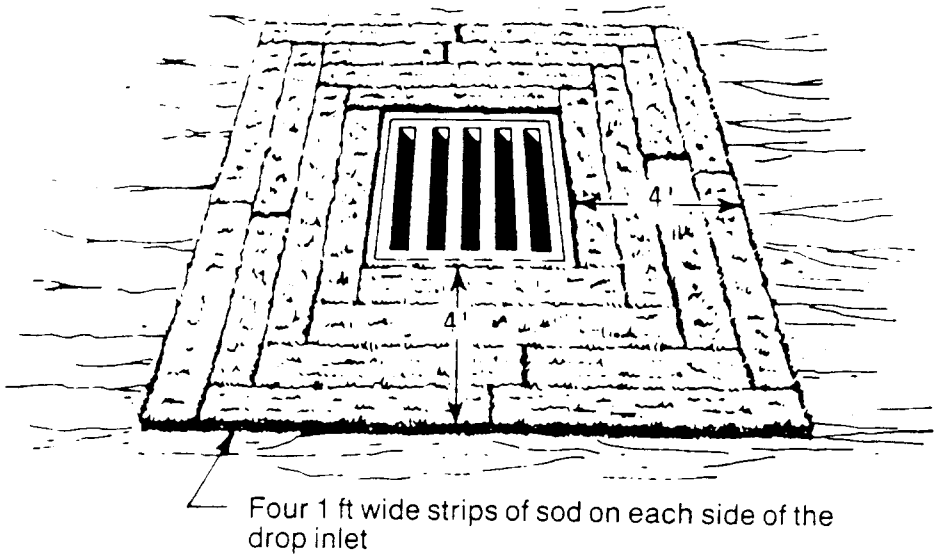


Figure 6-14.6 Sod strips protect inlet area from erosion (source: Va SWCC)

Temporary Sediment Basin

Sd3

DEFINITION

A basin created by the construction of a barrier or dam across a waterway or by excavating a basin or by a combination of both. They usually consist of a dam, a pipe outlet, and an emergency spillway. The size of the structure will depend upon the location, size of drainage area, soil type, and rainfall pattern.

PURPOSE

To detain runoff waters and trap sediment from erodible areas in order to protect properties and drainage ways below the installation from damage by excessive sedimentation and debris. The water is temporarily stored and the bulk of the sediment carried by the water drops out and is retained in the basin while the water is automatically released.

CONDITIONS

This practice applies to critical areas where physical site conditions, construction schedules, or other restrictions preclude the installation or establishment of erosion control practices to satisfactorily reduce runoff, erosion, and sedimentation. The structure may be used in combination with other practices and should remain in effect until the sediment-producing area is permanently stabilized.

This standard applies to the installation of temporary (to be removed within 18 months) sediment basins on sites where: (1) failure of the structure would not result in loss of life or interruption of use or service of public utilities, and (2) the drainage area does not exceed 150 acres.

* For EPA requirements on 10 or more disturbed acres see page 6-93

DESIGN CRITERIA FOR TEMPORARY SEDIMENT BASINS

Compliance With Laws and Regulations

Design and construction shall comply with State and local laws, ordinances, rules and regulations.

Location

The sediment basin should be located to obtain the maximum storage benefit from the terrain and for ease of cleanout of the trapped sediment. It should be located to minimize interference with construction activities and construction of utilities.

Sediment basins should be located so that storm drains discharge into the basin. They should never be placed in live streams.

Volume of the Basin *

Storage volume - Ensure that the sediment storage volume of the basin, as measured to the elevation of the crest of the principal spillway, is at least 67 cubic yards per acre for the disturbed area draining into the basin (67 cu. yds. is equivalent to 1/2 inch of sediment per acre of basin drainage area). Where possible, the entire drainage basin is used for this computation, rather than the disturbed area alone, to help ensure adequate trapping efficiency. Remove sediment from the basin when approximately one-third of the storage volume has been filled. This volume shall be marked on the riser or by setting a marked post near the riser. See Figure 6-15.1, p. 6-100 and 6-15.4, pg. 6-104.

Surface Area

Recent studies (Barfield and Clar, 1985) indicate that the following relationship between surface area and peak inflow rate gives a trapping efficiency from greater than 75% for clay loam to 95% for loamy sandy soils.

$$A = 0.01q$$

where A is basin surface area in acres and q is peak inflow rate in cfs. Area is measured at the crest of the principal spillway riser. The minimum peak inflow rate is determined from a 2-year, 24-hour storm.

Shape of the Basin

It is recommended that the designer of a sediment basin incorporate features to maximize travel time of flow within the basin. Suggested methods of accomplishing this objective are:

1. Length to width ratio greater than 2:1, where length is the distance between the inlet and outlet. Computation methods may be found on page 6-110.
2. A wedge shape with the inlet located at the narrow end.
3. Baffles or diversions may be used. Refer to page 6-110 and Figure 6-15.8, p. 6-111 .

The dimensions necessary to obtain the required basin volume and surface area shall be clearly shown on the plans to facilitate plan review, construction and inspection.

Spillways

Runoff may be computed by the method outlined in Appendix A. Other approved equivalent methods may be used. Runoff computations shall be based upon the worst soil-cover conditions expected to prevail in the contributing drainage area during the anticipated effective life of the structure. The combined capacities of the principal and emergency spillway shall be sufficient to pass the peak rate of runoff from a 25-year, 24-hour frequency storm.

1. Principal spillway - A spillway consisting of a vertical pipe or box type riser joined (watertight connection) to a pipe which shall extend through the embankment and outlet beyond the downstream toe of the fill shall be provided. The metal gage thickness shall comply with DOT or SCS specifications. The discharge shall be based on a 2-year, 24-hour storm for the total drainage area without causing flow through the emergency spillway. The appropriate disturbed soil cover condition shall be used. The minimum size of the pipe shall be 8 inches in diameter. Principal spillway capacities may be determined from Table 6-15.1, p. 6-101. Weir flow discharge above the crest of the riser, may be determined from Table 6-15.2, p. 6-102. Principal spillway pipe, riser pipe, and trash rack dimensions are shown in Table 6-15.3, p. 6-102.

    a. Crest elevation - The crest elevation of the riser shall be a minimum of one foot below the elevation of the control section of the emergency spillway.

    b. Watertight barrel assembly - The riser and all pipe connections shall be completely watertight except for the inlet opening at the top or dewatering openings, and shall not have any other holes, leaks, rips or perforations. See Figure 6-15.2, p. 6-103.

    c. Dewatering the basin - Retention time within the basin is an important factor in effective sedimentation retention.

    Methods may include:

    1. Perforating the entire riser with 1/2" diameter holes. Use #57 or #5 stone on the lower 1/3 computed sediment storage volume section of the riser.
    2. Perforating only the upper 2/3 computed sediment storage volume section of the riser creating a ponding area.

    d. Trash rack and anti-vortex device - A trash rack and anti-vortex device shall be securely installed on top of the riser and may be the type as shown in Figure 6-15.3, p. 6-104.

    e. Base - The riser shall have a base attached with a watertight connection and shall have sufficient weight to prevent flotation of the riser. A concrete base 18" thick with the riser embedded 9" in the base is recommended. Computations shall be made to design a base which will prevent flotation. The minimum factor of safety shall be 1.20 (downward forces = 1.20 x upward forces). See Figure 6-15.5, p. 6-105 and Table 6-15.4, p. 6-106 for details.

    f. Anti-Seep Collars - One anti-seep collar shall be installed around the pipe, near the center of the dam, when any of the following conditions exist:

        1. The settled height of the dam is greater than 15 feet.
        2. The conduit is smooth pipe larger than 8" in diameter.
        3. The conduit is corrugated metal pipe larger than 12" in diameter.

    Use an anti-seep collar with an 18-inch projection for heads (H) less than or equal to 10 feet and a 24-inch projection for heads (H) greater than 10 feet.

    The anti-seep collar and its connection shall be watertight.

    g. Outlet - An outlet shall be provided, including a means of conveying the discharge in an erosion-free manner to an existing stable channel. Where discharge occurs at the property

line, drainage easements will be obtained in accordance with local ordinances. Adequate notes and references will be shown on the erosion and sediment control plan. Protection against scour at the discharge end of the pipe spillway shall be provided. Measures may include excavated plunge pools, riprap, impact basins, revetments, or other approved methods.

h. For typical features of a temporary sediment basin, see Figure 6-15.4, p. 6-104. Also, see Figure 6-15.6, p. 6-107 for a typical drawing to be included in design plans.

2. Emergency Spillway - The entire flow area of the emergency spillway shall be constructed in undisturbed ground (not fill). The emergency spillway cross-section shall be trapezoidal with a minimum bottom width of eight feet. This spillway channel shall have a straight control section of at least 20 feet in length and a straight outlet section for a minimum distance equal to 25 feet. See Figure 6-15.7, p. 6-108.

   a. Capacity - The minimum capacity of the emergency spillway shall be that required to pass the peak rate of runoff from the 25-year, 24-hour frequency storm, less any reduction due to flow in the principal spillway. The appropriate disturbed soil cover condition shall be used . Emergency spillway dimensions may be determined by using the method described in this section. Refer to Table 6-15.5, p. 6-109 and Figure 6-15.7, p. 6-108.

   b. Velocities - The velocity of flow in the exit channel shall not exceed 5 feet per second for vegetated channels. For channels with erosion protection other than vegetation, velocities shall be within the non-erosive range for the type of protection used.

   c. Erosion Protection - Vegetation, riprap, asphalt or concrete shall be provided to prevent erosion .

   d. Freeboard - Freeboard is the difference between the design high water elevation in the emergency spillway and the top of the settled embankment. The freeboard shall be at least one foot.

Entrance of Runoff Into Basin

Points of entrance of surface runoff into excavated sediment basins shall be protected to prevent erosion and sediment generation. Dikes, swales or other water control devices shall be installed as necessary to direct runoff into the basin. Points of runoff entry should be located as far away from the riser as possible, to maximize travel time.

CONSTRUCTION SPECIFICATIONS

Site Preparation

Areas under the embankment and under structural works shall be cleared, grubbed, and stripped of topsoil. All trees, vegetation, roots and other objectionable material shall be removed and disposed of by approved methods. In order to facilitate clean-out or restoration, the pool area (measured at the top of the pipe spillway) will be cleared of all brush and trees.

Cut-off Trench

A cut-off trench will be excavated along the centerline of earth fill embankments. The minimum depth shall be 2 feet. The cut-off trench shall extend up both abutments to the riser crest elevation. The minimum bottom width shall be 4 feet, but wide enough to permit operation of compaction equipment. The side slopes shall be no steeper than 1:1. Compaction requirements shall be the same as those for the embankment. The trench shall be drained during the backfilling and compaction operations.

Embankment

The fill material shall be taken from approved areas shown on the plans. It shall be clean mineral soil free of roots, woody vegetation, oversized stones, rocks or other objectionable material. Relatively pervious materials such as sand or gravel (Unified Soil Classes GW, GP, SW & SP) shall be placed in the downstream section of the embankment. Areas on which fills are to be placed shall be scarified prior to placement of fill. The fill material shall contain sufficient moisture so that it can be formed by hand into a ball without crumbling. If water can be squeezed out of the ball, it is too wet for proper compaction. Fill material shall be placed in six-inch to eight-inch thick continuous layers over the entire length of the fill. Compaction shall be obtained by routing and hauling the construc-

tion equipment over the fill so that the entire surface of the fill is traversed by at least one wheel or tread track of the equipment or by the use of a compactor. The embankment shall be constructed to an elevation 5 percent higher than the design height to allow for settlement.

Principal Spillway

The riser shall be securely attached to the pipe or pipe stub by welding the full circumference making a watertight structural connection. The pipe stub must be attached to the riser at the same percent (angle) of grade as the outlet conduit. The connection between the riser and the riser base shall be watertight. All connections between pipe sections must be achieved by approved watertight band assemblies (See Figure 6-15.2, p. 6-103 for details). The pipe and riser shall be placed on a firm, smooth foundation of impervious soil as the embankment is constructed. Breaching the embankment is unacceptable. Pervious materials such as sand, gravel, or crushed stone shall not be used as backfill around the pipe or anti-seep collar. The fill material around the pipe spillway shall be placed in four inch layers and compacted under and around the pipe to at least the same density as the adjacent embankment. Care must be taken not to raise the pipe from firm contact with its foundation when compacting under the pipe haunches. A minimum depth of two feet of hand compacted backfill shall be placed over the pipe spillway before crossing it with construction equipment.

Emergency Spillway

The emergency spillway shall be installed in undisturbed ground. The achievement of planned elevations, grades, design width, entrance and exit channel slopes are critical to the successful operation of the emergency spillway and must be constructed within a tolerance of +/- 0.2 feet.

Vegetative Treatment

Stabilize the embankment and all other disturbed areas in accordance with the appropriate vegetative measure, Ds3, immediately following construction. In no case shall the embankment remain unstabilized for more than seven (7) days.

Erosion and Pollution Control

Construction operations will be carried out in such a manner that erosion and water pollution will be minimized. State and local laws concerning pollution abatement shall be complied with.

Safety

State and local requirements shall be met concerning fencing and signs warning the public of hazards of soft sediment and floodwater.

MAINTENANCE

Repair all damages caused by soil erosion or construction equipment at or before the end of each working day.

Sediment shall be removed from the basin when it reaches the specified distance below the top of the riser. This sediment shall be placed and stabilized in such a manner that it will not erode from the site. The sediment shall not be deposited downstream from the embankment, adjacent to a stream or floodplain.

FINAL DISPOSAL

When temporary structures have served their intended purpose and the contributing drainage area has been properly stabilized, the embankment and resulting sediment deposits are to be leveled or otherwise disposed of in accordance with the approved sediment control plan. The proposed use of a sediment basin site will often dictate final disposition of the basin and any sediment contained therein. If the site is scheduled for future construction, then the embankment and trapped sediment must be removed, safely disposed of, and backfilled with a structural fill. When the basin area is to remain open space, the pond may be pumped dry, graded and backfilled.

TEMPORARY OR PERMANENT SEDIMENT BASIN
(EPA REQUIREMENTS FOR 10 OR MORE DISTURBED ACRES)

For common drainage locations that serve an area with 10 or more disturbed acres at one time, a temporary (or permanent) sediment basin providing 3,600 cubic feet of storage per acre drained, or equivalent control measures (such as suitably sized dry wells or infiltration structures), shall be provided where economically attainable until final stabilization of the site. The 3,600 cubic feet of storage area per acre drained does not apply to flows from offsite areas and flows from onsite areas that are either undisturbed or have undergone final stabilization where such flows are diverted around the sediment basin. For drainage locations which serve 10 or more disturbed acres at one time and where a temporary sediment basin providing 3,600 cubic feet of storage per acre drained, or equivalent controls is not economically attainable, sediment traps should be used. At a minimum, silt fences or equivalent sediment controls are required for all sideslope and downslope boundaries of the construction area.

For drainage locations serving less than 10 acres, sediment traps, silt fences or equivalent sediment controls are required for all sideslope and downslope boundaries of the construction area unless a sediment basin providing storage for 3,600 cubic feet of storage per acre drained is provided.

EPA has established the 3,600 cubic feet per disturbed acre criteria based on an evaluation of the 2-year, 24-hour storm. The Agency selected a 3-inch storm event as representative of the 2-year, 24-hour storm based on the evaluation of the 2-year, 24-hour storm in a number of locations. The Agency further assumed that a 3-inch storm will generate 1 inch of runoff which is approximately 3,600 cubic feet. (This assumes that one-third of the rainfall runs off the site, and two-thirds of the rainfall is infiltrated at the site). The 3,600 cubic foot criterion has also been identified in "Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters," EPA, May 1991, as being able to handle 90 percent of the storm each year.

Information to be Submitted

Sediment basin designs and construction plans submitted for review to the Soil and Water Conservation District or other agencies shall include the following:

1. Specific location of the basin.

2. Plan view of the storage basin and emergency spillway showing existing and proposed contours.

3. Cross section of dam, principal spillway and emergency spillway, and profile of emergency spillway. The cross section shall include information similar to that shown in Figure 15.6, p. 6-107.

4. Details of pipe connections, riser to pipe connections, riser base, anti-seep collars, trash rack, cleanout elevation, and anti-vortex device.

5. Runoff calculations for the 2-year frequency principal spillway storm and the disturbed condition 25-year frequency emergency spillway storm.

6. Storage Computations

   a. Total required

   b. Total available

   c. Level of sediment at which cleanout shall be required shall be stated as a distance from the riser crest to the sediment surface.

7. Calculations showing design of pipe and emergency spillway.

8. Maintenance equipment access points.

TEMPORARY SEDIMENT BASIN DESIGN DATA SHEET

Computed by_____ Date_____
Checked by_____ Date_____

Project_____
Basin #_____
Total area draining to basin, _____ acres.

Basin Volume Design

1. Min. required vol. = 67 yd^3 x _____ ac. drainage are = _____ yd^3
2. Vol. of basin at cleanout (V_c)
   V_c = 22 yd^3 x _____ ac. drainage area = _____ yd^3
3. Elevation corresponding to min. req. vol. of basin _____ft.
4. Elevation corresponding to cleanout basin _____ ft.
5. Distance below top of riser _____ ft.

Design of Spillways

Runoff

6. Q_2 = _____ cfs Disturbed condition peak discharge from 2-yr/24-hr storm event.
   Attach runoff computation sheet.

   Q_{25} = _____ cfs Disturbed condition peak discharge from 25-year/24-hr storm event.
   Attach runoff computation sheet.

Principal Spillway (Q_{PS})

Maximum principal spillway cap., $Q_{PS} = Q_2$ = _____ cfs

7. H = _____ ft. Pipe length = _____ ft.
8. Pipe Diam. _____ in.
   Q_{PS} = (Q) _____ x (corr. factor) _____ = _____ cfs.
9. Riser Diam. _____ in.; Length _____ ft.; h = _____ ft.
10. Trash rack Diam. _____ in.

Emergency Spillway (Q_{ES})

11. Emergency spillway cap. = $Q_{25} - Q_{PS}$ = _____ - _____ = _____ cfs
12. Width _____ ft.; H_p _____ ft.
13. Entrance channel slope _____ %.
14. Exit channel slope _____ %.

Anti-Seep Collar Design

15. Use 1 anti-seep collar, if required: yes _____ no _____

Design Elevations

16. Riser Crest = _____ ft.
    Em. Spwy. Crest = _____ ft.
    Design High Water = Em. Spwy. Crest Elev. + H_p =
    = _____ + _____ = _____ ft.
    Top of Dam = Design High Water + 1 foot freeboard = _____ ft.

Surface Area Design

17. Minimum basin surface area;
    SA = 0.01 x Q_{PS} = 0.01 x _____ cfs = _____ acre

TEMPORARY SEDIMENT BASIN DESIGN DATA SHEET
INSTRUCTIONS FOR USE OF FORM

1. The minimum required volume of storage is 67 cubic yards per acre for each acre of disturbed drainage area, although when possible, the total drainage area should be used. Volume should be computed from contour information. A stage-storage curve should be developed for the site showing elevation versus accumulated volume. The contour map is used to measure areas for various contour intervals from the basin bottom to the expected top of dam elevation. The storage volume within the basin is usually natural storage and storage gained from excavated soil that will be used for construction of the dam.

2. The volume of the basin for cleanout of sediment is 22 cubic yards per acre for each acre of drainage area. As the basin fills with sediment to this volume, the sediment shall be removed to restore the original design volume.

3. Determine the design elevation for the minimum required storage volume of the basin. The design elevation is set at the principal spillway riser crest to provide the required 67 cubic yards per acre of drainage area.

4. Determine the design elevation of the sediment cleanout pool level. The basin shall be dewatered to this elevation using perforations in the riser pipe. This design elevation corresponds to the 22 cubic yards per acre.

5. Determine the distance of basin cleanout below the riser crest. The cleanout elevation shall be clearly marked on the riser or by use of a marked post near the riser.

6. Compute the peak discharge rates (for the 2-year and 25-year, 24-hour storm events) for the principal and emergency spillways using methods described in Appendix A. The worst disturbed land-use condition shall be used, reflected by the curve number used.

7. Determine the value of "H" from site conditions. "H" is the vertical distance between the centerline of the outlet pipe and the emergency spillway crest. Determine the pipe length, Figure 6-15.1, p. 6-100.

8. Determine the pipe diameter and Q_{ps} to pass the 2-year peak discharge (Q_2) using Table 6-15.1, p. 6-101.

9. Use Tables 6-15.2 and 6-15.3, p. 6-102 to determine the riser diameter, and "h" feet or 1 foot below the emergency spillway, whichever is greater.

10. Determine the trash rack anti-vortex device size using the Table 6-15.3, p. 6-102.

11. Compute the emergency spillway capacity (Q_{ES}) by subtracting the actual flow carried by the principal spillway from Q_{25}.

12. Use Table 6-15.5, p. 6-109 to obtain values of *Hp* and bottom width for the emergency spillway.

13. Determine the emergency spillway entrance channel slope.

14. Determine an emergency spillway exit channel slope.

15. Specify an anti-seep collar, if required.

16. Determine the design elevations of the riser crest, emergency spillway, design high water, and the top of the dam.

17. Determine the minimum surface area required.

TEMPORARY SEDIMENT BASIN DESIGN EXAMPLE

Given: Total Drainage Area = 8 acres (all disturbed)
Peak Runoff (2 year, 24 hour rain) = 18 cfs
Peak Runoff (25 year, 24 hour rain) = 45 cfs
Head (from crest of emergency spillway to centerline of outlet pipe) = 11 feet

Solution:

1. Compute the minimum required storage volume:
   V_s = 67 cu. yd. / ac x 8 ac = 536 cu. yd.

2. Compute the maximum volume accumulated in basin at required cleanout time:
   V_c = 22 cu. yd. / ac x 8 ac = 176 cu. yd.

3. Compute the minimum surface area of basin:
   Area = 0.01q
   Area = 0.01 x 18 cfs = 0.18 acre or 7841 sq. ft.

4. Compute the required length of basin (length is two times width):
   Width = 65 feet
   Required length = 130 feet

5. Check basin area to confirm that the minimum surface area required is available:
   Minimum surface area = 7841 sq. ft.
   Available surface area = 65 ft. x 130 ft. or 8450 sq. ft.

6. Determine the principal spillway conduit (pipe) system and diameters to meet required discharge of 18 cfs:
   a. From pipe flow Table 6-15.1, p. 6-101 select an 18 inch pipe diameter for a head (H) of 11 feet.
   b. From Table 6-15.3, p. 6-102 determine the required riser and trash rack diameters. For an 18 inch diameter pipe, Table 6-15.3, p. 6-102 shows a 24 inch riser pipe and a 36 inch trash rack.
   c. Using the formula given on Figure 6-15.1, p. 6-100 compute the pipe length (L).
   d. Since the head (H) equals 11 feet, an anti-seep collar having a 24-inch projection is required.

7. Determine the volume of concrete required to prevent flotation of the riser:
   The 24 inch diameter riser is 9 feet high.
   From Table 6-15.4, p. 6-106, 2.75 cu. ft. of concrete per foot of riser height is required, providing a factor of safety of 1.20.
   Volume of concrete = 2.75 cu. ft. x 9 ft. = 24.8 cu. ft. = 0.92 cu. yd., Use 1 cu. yd.

8. Determine if pipe outlet protection is needed:
   The discharge with an 11 ft. head is 18.2 cfs, Table 6-15.1, p. 6-101. The area of an 18 inch pipe is 1.77 sq. ft.

   Velocity = Q/A = 18.2/1.77 = 10.3 feet per second.

   For exit velocities greater than 5 fps:
   Select the proper size rock riprap for a velocity of 10 fps.

   A rock-lined distilling basin is a design option. For larger diameter distilling basins, a smaller rock may be used.

9. Design the emergency spillway:
   $Q_{ES} = Q_{25} - Q_{PS} = 45$ cfs - 18 cfs = 27 cfs

   From emergency spillway design Table 6-15.5, p. 6-109:
   For a stage or flow depth of 1.0 foot, the bottom width is 12 feet for Q = 29 cfs.
   The outlet velocity is 4 fps with a 3% exit slope.

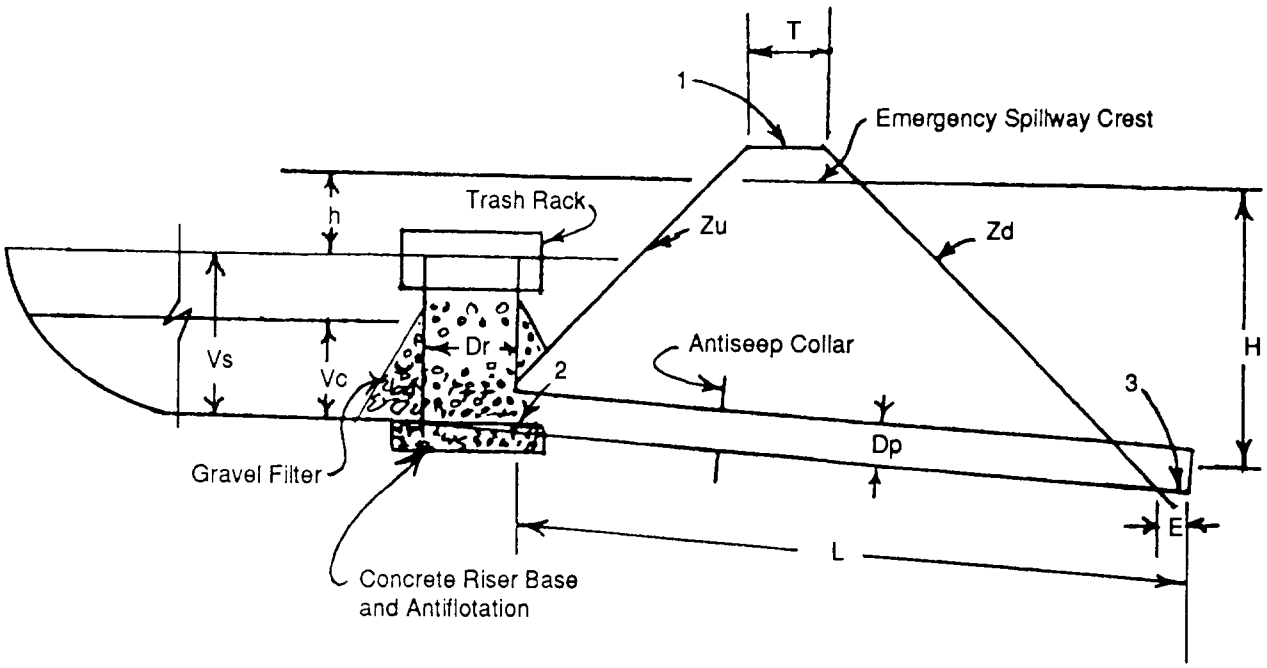
   Prepare the drawing, using Emergency Spillway Layout Drawing in Figure 6-15.7, p. 6-108 for guidance.

10. Design the embankment:
    Set the top of dam elevation 1 foot higher than the stage flow depth of the emergency spillway.

    The constructed height of dam is 5% higher than design height to allow for settlement.

    Use side slopes of 2.5 horizontal to 1 vertical or flatter.

    Use proper vegetative specifications to control erosion on dam, emergency spillway and all other critical areas created during construction.



BASIN CROSS-SECTION

BASIN VOLUME DESIGN

Vs = Sediment storage volume = 67 cu.yds./acre drainage area

Vc = Volume of cleanout = 22 cu. yds./acre drainage area

PRINCIPAL SPILLWAY DESIGN

H = Head on pipe spillway, ft.

h = Head over riser crest, ft.

Dp = Diameter of pipe conduit, in.

Dr = Diameter of riser, in.

T = Top width of dam, ft.

Zu = Upstream side slope

Zd = Downstream side slope

1 = Top of dam elevation

2 = Lowest elev. of pipe at riser

3 = Lowest elev. of pipe at outlet

E = Extended length of pipe beyond toe of dam

L = Total length of pipe, ft.

$L = [1 - (2 + 3)/2] [Zu + Zd] + T + E$

TERMINOLOGY FOR BASIN DESIGN

Figure 6-15.1

PIPE FLOW CHART FOR CORRUGATED METAL PIPE DROP INLET PRINCIPAL SPILLWAY CONDUIT

For Corrugated Metal Pipe Inlet $K_m = K_a + K_b = 1.0$ and 70 Feet of Corrugated Metal Conduit (full flow assumed), n = 0.025
(Note correction factors for pipe lengths other than 70 feet)

	Diameter Of Pipe In Inches							
H, in feet	8"	12"	18"	24"	30"	36"	42"	48"
	Discharge In Cubic Feet Per Second							
3	1.22	3.43	9.48	19.1	32.6	49.9	71.2	96.5
4	1.40	3.97	10.9	22.1	37.6	57.7	82.3	111
5	1.57	4.43	12.2	24.7	42.1	64.5	92.0	125
6	1.72	4.86	13.4	27.0	46.1	70.6	101	136
7	1.86	5.25	14.5	29.2	49.8	76.3	109	147
8	1.99	5.61	15.5	31.2	53.2	81.5	116	158
9	2.11	5.95	16.4	33.1	56.4	86.5	123	167
10	2.22	6.27	17.3	34.9	59.5	91.2	130	176
11	2.33	6.58	18.2	36.6	62.4	95.6	136	185
12	2.43	6.87	19.0	38.2	65.2	99.9	142	193
13	2.53	7.15	19.7	39.8	67.8	104	148	201
14	2.63	7.42	20.5	41.3	70.4	108	154	208
15	2.72	7.68	21.2	42.8	72.8	112	159	216
16	2.81	7.93	21.9	44.2	75.2	115	165	223
17	2.90	8.18	22.6	45.5	77.5	119	170	230
18	2.98	8.41	23.2	46.8	79.8	120	174	236
19	3.06	8.64	23.9	48.1	82.0	126	179	243
20	3.14	8.87	24.5	49.4	84.1	129	184	249
L, in feet	Correction Factors For Other Pipe Lengths							
30	1.41	1.36	1.29	1.24	1.21	1.18	1.15	1.13
40	1.27	1.23	1.20	1.17	1.14	1.12	1.11	1.10
50	1.16	1.14	1.12	1.10	1.09	1.08	1.07	1.06
60	1.07	1.06	1.05	1.05	1.04	1.04	1.03	1.03
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	0.94	0.95	0.95	0.96	0.96	0.97	0.97	0.97
90	0.89	0.90	0.91	0.92	0.93	0.94	0.94	0.95
100	0.85	0.86	0.88	0.89	0.90	0.91	0.92	0.93
120	0.79	0.90	0.82	0.83	0.85	0.86	0.87	0.89
140	0.73	0.75	0.77	0.79	0.81	0.82	0.84	0.85
160	0.69	0.70	0.73	0.75	0.77	0.79	0.80	0.82

Table 6-15.1

WEIR FLOW (Q) OVER RISER CREST FOR CIRCULAR RISERS WITH TRASH RACK

$$Q = CLh^{3/2}$$

$$Q = 3.1 \times (\pi) \times (D/12) \times h^{3/2}$$

HEAD-h in feet	Riser Diameter (D_r) in inches								HEAD-h in feet
	12	18	24	30	36	48	54	60	
				Flow In Cubic Feet Per Second					
0.1	0.3	0.5	0.6	0.8	0.9	1.2	1.4	1.5	0.1
0.2	0.9	1.3	1.7	2.2	2.6	3.5	3.9	4.4	0.2
0.3	1.6	2.4	3.2	4.0	4.8	6.4	7.2	8.0	0.3
0.4	2.5	3.7	4.9	6.2	7.4	9.9	11.1	12.3	0.4
0.6	4.5	6.8	9.1	11.3	13.6	18.1	20.4	22.6	0.6
0.8		10.5	13.9	17.4	20.9	27.9	31.4	34.8	0.8
1.0			19.5	24.3	29.2	39.0	43.8	48.7	1.0
1.2			25.6	32.0	38.4	51.2	57.6	64.0	1.2
1.4				40.3	48.4	64.5	72.6	80.7	1.4
1.6				49.3	59.1	78.8	88.7	98.6	1.6
1.8					70.6	94.1	105.8	117.6	1.8
2.0					82.6	110.2	124.0	137.7	2.0
2.2						127.1	143.0	158.9	2.2
2.4							162.9	181.0	2.4
2.6							183.7	204.1	2.6
2.8								228.1	2.8
3.0								253.0	3.0

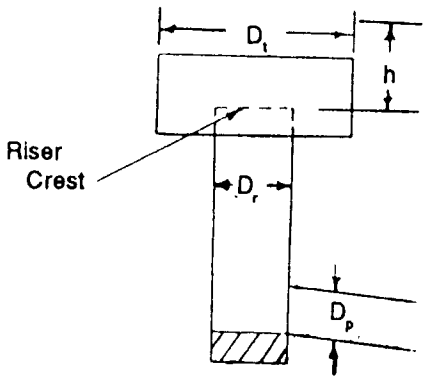
PIPE, RISER, AND TRASH RACK PROPORTIONS

Diameters in Inches

Principal Spillway Pipe D_p	Riser Pipe D_r	Trash Rack D_t
8	12	24
12	18	30
15	21	30
18	24	36
24	30	42
30	36	54
36	48	66
42	54	72
48	60	84

Table 6-15.3 - Design Chart For Conduit Pipe, Riser, And Trash Rack Diameters

Table 6-15.2



EXAMPLE:
The peak runoff for a 2 year, 24 hour rain is 32 cfs. Select a pipe size for a head of 12 feet and length of 100 feet. From Table 6-15.1, 38.2 x 0.89 = 34 cfs discharge for a 24 inch diameter pipe.

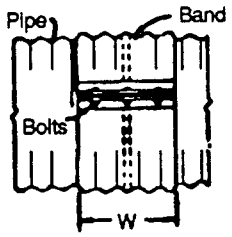
From Table 6-15.3, the diameter of the riser is 30 inches and the trash rack is 42 inches.

From Table 6-15.2, 1.2 foot of head (h) above the crest of the riser is required to discharge 32 cfs.

NOTE: h = minimum distance between the crest of the riser and the crest of the emergency spillway.

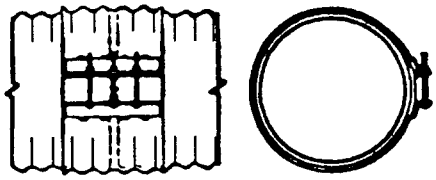
TYPES OF COUPLERS FOR CORRUGATED STEEL PIPE

(ALL CONNECTOR BANDS REQUIRE NEOPRENE GASKETS)



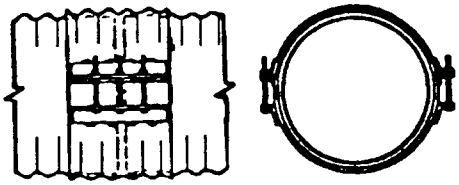
SIDE VIEW

ANNULAR COUPLING BAND



SIDE VIEW END VIEW

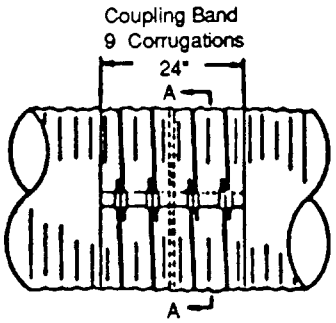
ONE PIECE LAP-TYPE COUPLING FOR ANNULAR OR HELICAL PIPE - 12" AND 24" WIDTHS



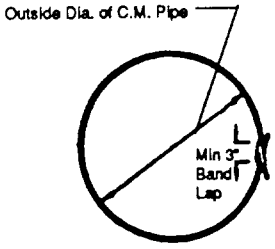
SIDE VIEW END VIEW

TWO PIECE LAP-TYPE COUPLING FOR ANNULAR OR HELICAL PIPE - 12" AND 24" WIDTHS

STANDARD LAP-TYPE COUPLING BANDS FOR ANNULAR C.S.P. OR HELICAL C.S.P.



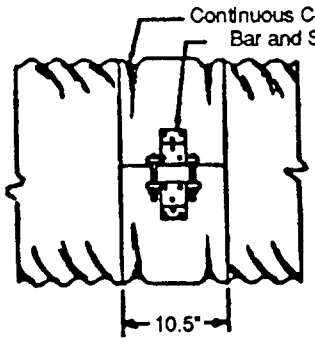
SIDE VIEW



SECTION A-A

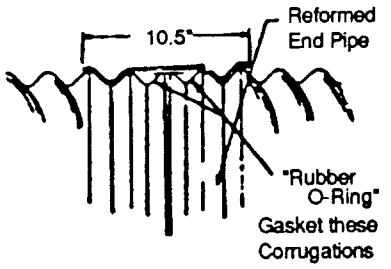
PIPE DIAMETER 18" TO 48" INC.

ROD AND LUG TYPE



SIDE VIEW

HUGGER TYPE COUPLING BAND FOR REFORMED END H.C.S.P. OR ANNULAR C.S.P.

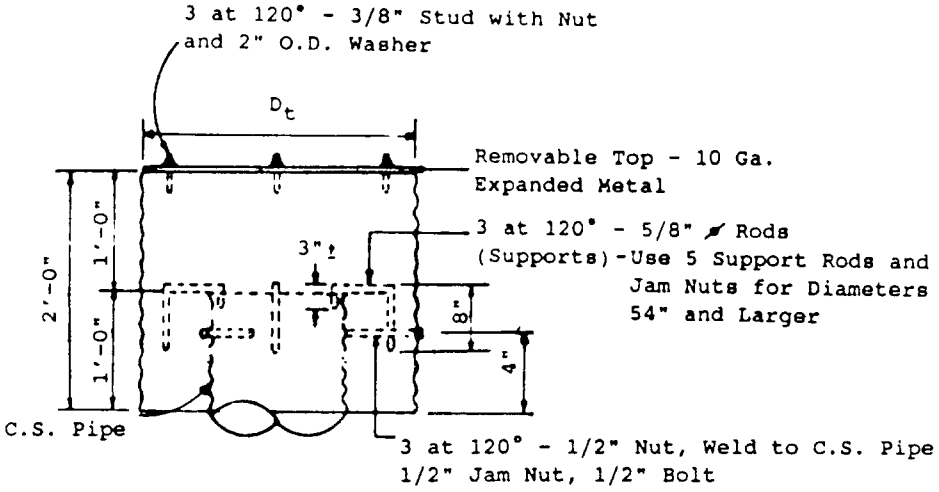


SECTION VIEW

NOTES:

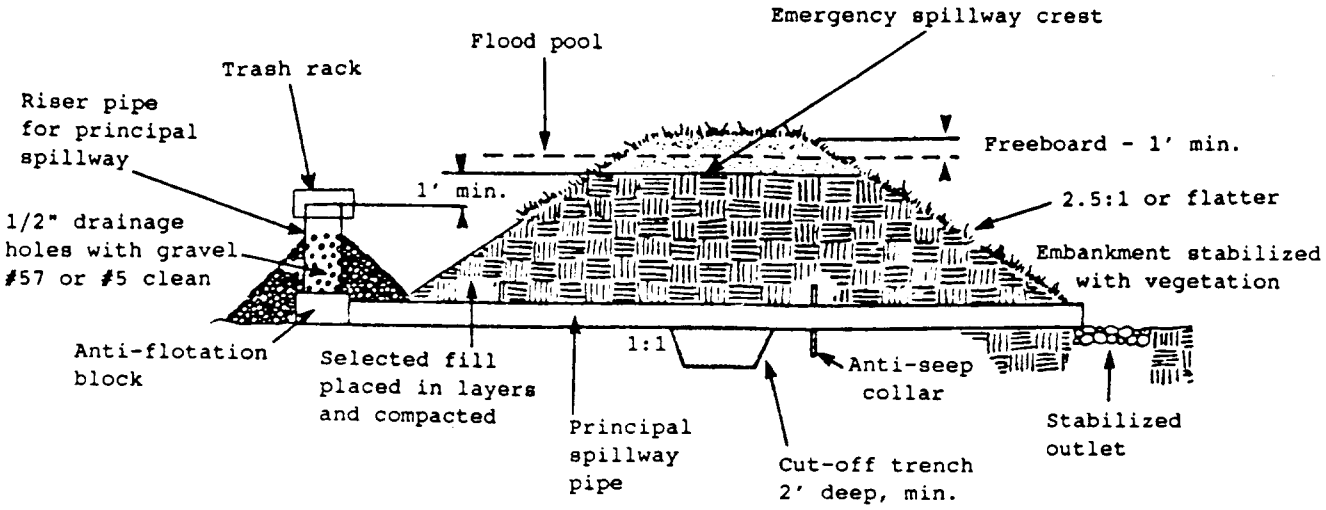
1. UNDER NO CIRCUMSTANCE WILL THE DIMPLE (UNIVERSAL) CONNECTOR BAND BE ACCEPTABLE FOR USE IN ANY SEDIMENT CONTROL OR STORMWATER MANAGEMENT STRUCTURE.
2. RODS AND LUGS SHOULD BE USED WITH ALL HUGGER TYPE CONNECTING BANDS.
3. 8" AND 12" DIAMETER PIPES - USE FLANGE CONNECTORS WITH A GASKET.

Figure 6-15.2



Typical Trash Rack

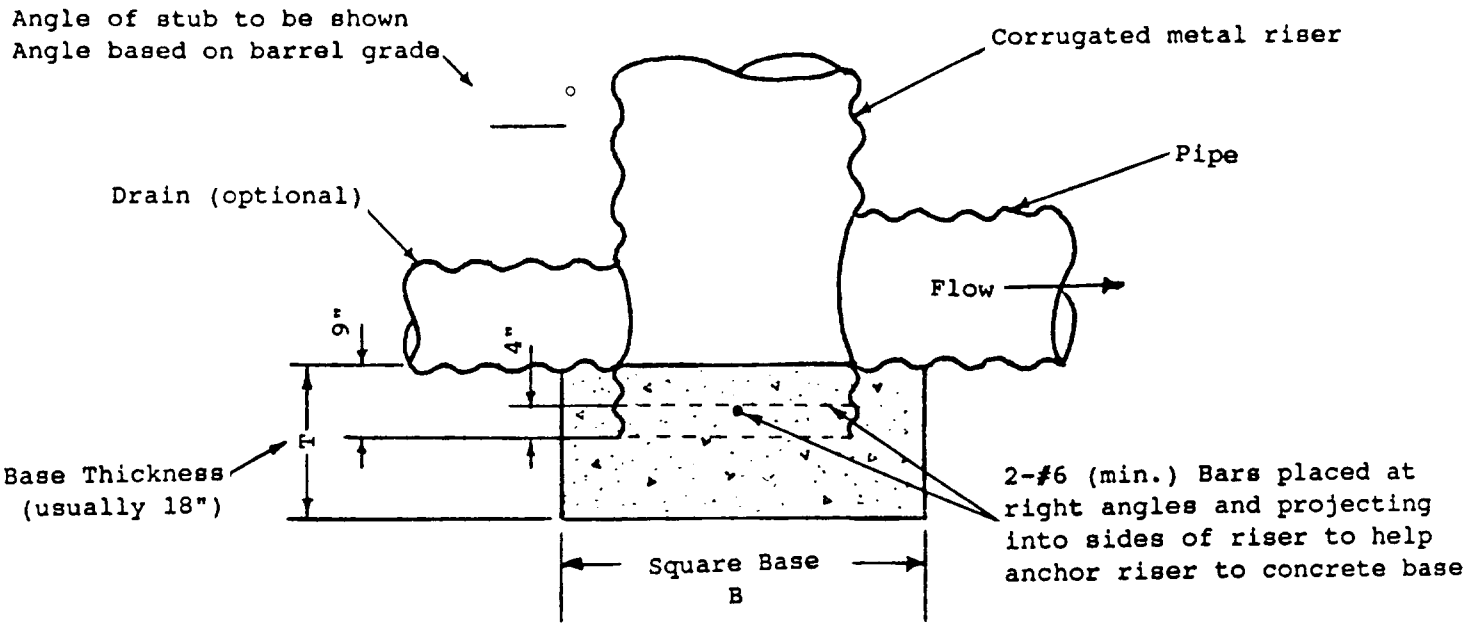
Figure 6-15.3



Section through Embankment and Typical Features

Fill Height	Minimum Top Width
less than 10 ft	8.0 ft
10 feet to 15 ft	10.0 ft

Figure 6-15.4



CONCRETE RISER BASE DETAIL

Base Dimension Computation Example:

It has been determined that 27 cubic feet of concrete is required for a 24 inch diameter riser. First the base area (A) is calculated. Next the base length and width (B), which are the same for a square base, are calculated.

1. $A = V/T = 27$ cu. ft./1.5 ft. = 18 sq. ft.

2. $B = \sqrt{A} = \sqrt{18 \text{ sq. ft.}} = 4.24$ ft.

Use 4 ft. and 3 in.

NOTE: With aluminum or aluminized pipe, the embedded section must be painted with zinc chromate or equivalent.

Figure 6-15.5

CONCRETE VOLUME REQUIRED TO PREVENT FLOTATION OF RISER

Riser Pipe Diameter (in)	Buoyant Force (lbs /V.F. of Riser Height)[1]	Volume of Concrete per Vertical Foot of Riser Height (c.f./V.F.) Needed to Prevent Flotation[2]
12	49.0	0.69
18	110.3	1.54
21	150.1	2.10
24	196.0	2.75
30	306.3	4.29
36	441.1	6.18
48	784.1	10.98
54	992.4	13.90
60	1225.2	17.16

EXAMPLE: Find the volume of concrete required to stabilize a 24 inch diameter riser 10 feet high.

VOL. = (2.75 cu.ft./V.F.) (10 feet) = 27.5 cu. ft. = 1 cu. yd.

1

The weight of the riser pipe is neglected. For example, the area of a 24 inch riser pipe is 3.1416 square feet. The volume of 1 vertical foot is 3.1416 cubic feet . Therefore, Buoyant Force (per vertical foot) = VOL x WEIGHT OF WATER

BUOYANT FORCE = 3.1416 ft^3 • 62.4 lbs/ft^3 = 196.0 lbs

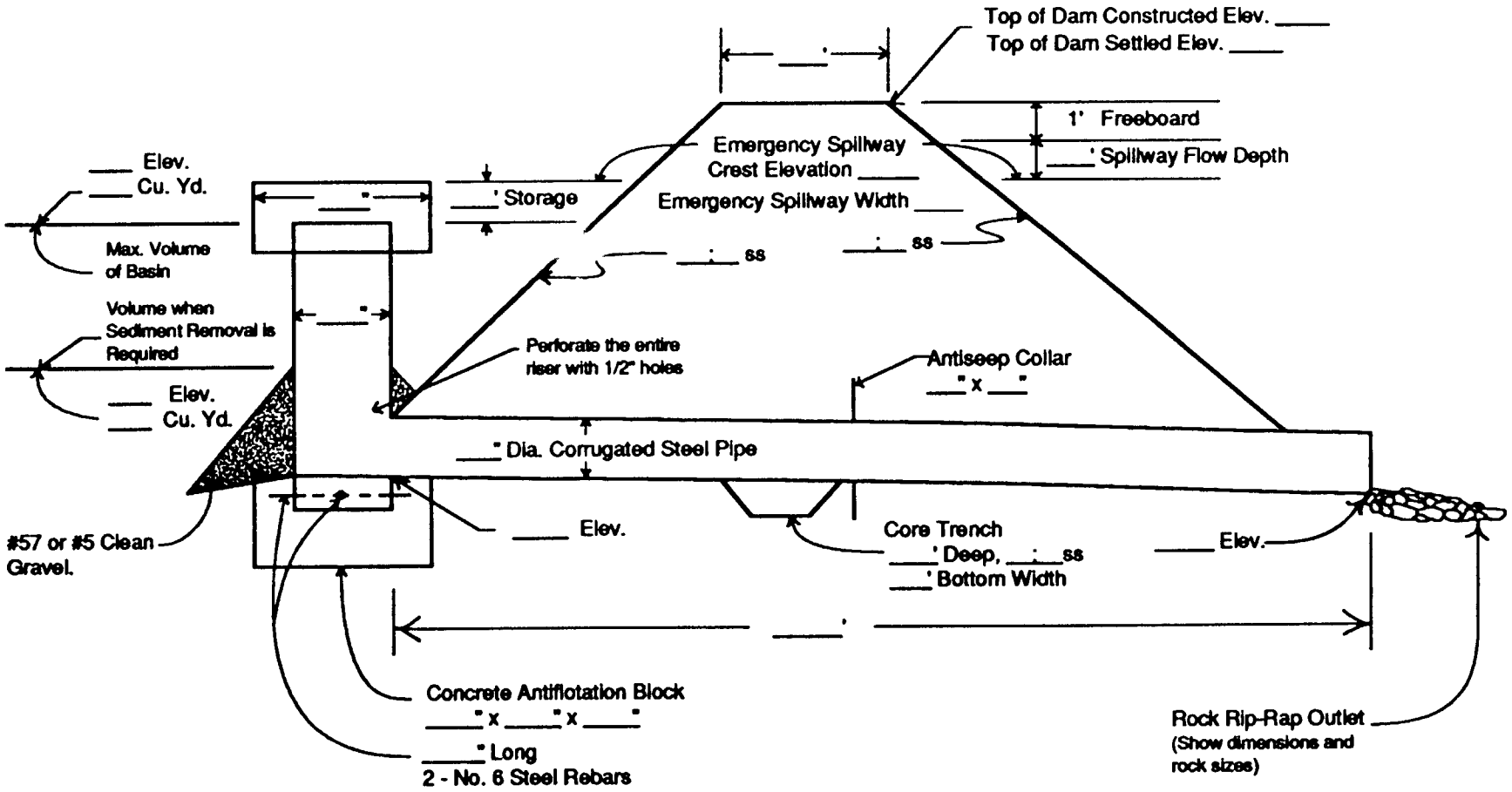
2

Concrete weighs approximately 4,000 pounds per cubic yard or 148.1 pounds per cubic foot. The Effective Downward Force of Concrete = WEIGHT OF CONCRETE - WEIGHT OF WATER = 148.1 lbs/ft^3 - 62.4 lbs/ft^3 = 85.7 lbs/ft^3.

For a factor of safety of 1.2, the Effective Weight of Concrete = 85.7 lbs/ft^3 / (1.2) = 71.4 lbs/ft^3.

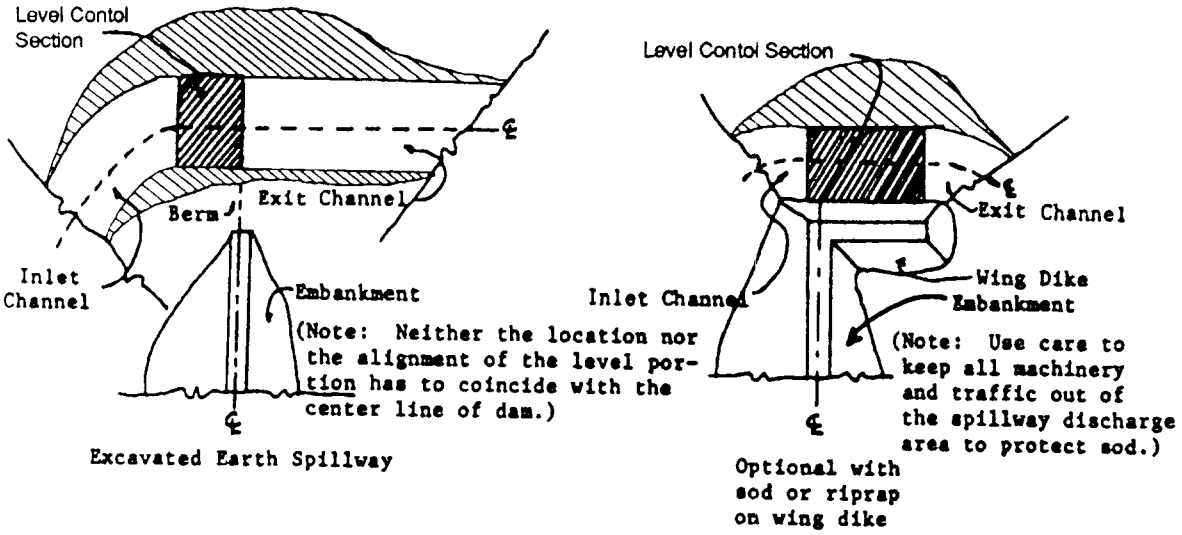
For the 36 inch diameter riser, 441.1 pounds of buoyant force for one vertical foot of riser divided by 71.4 pounds per cubic foot effective weight of concrete gives a volume of 6.18 cubic feet of concrete required per vertical foot of riser height and provides a factor of safety of 1.2.

Table 6-15.4

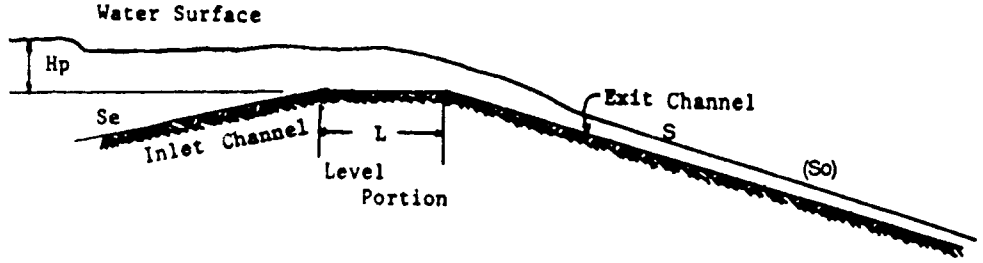


TEMPORARY SEDIMENT BASIN DETAILS

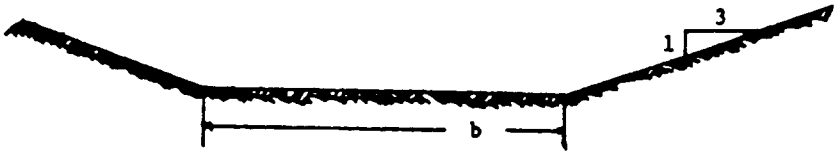
Figure 6-15.6



PLAN VIEW OF EARTH SPILLWAYS



PROFILE ALONG CENTERLINE



CROSS-SECTION OF CONTROL SECTION

LEGEND:

Hp = Difference in Elevation between Crest of Earth Spillway at the Control Section and Water Surface in resevoir, in feet.
b = Bottom Width of Earth Spillway at the Control Section, in feet.
Q = Total Discharge, in cfs.
V = Velocity, in feet per second, that will exist in Channel below Control Section, at Design Q, if constructed to slope (S) that is shown.
S = Flattest Slope (S), in %, allowable for Channel below Control Section.

NOTES:

1. For Q, V, S relationship see the chart on the following page.
2. For a given Hp, a decrease in the exit slope as given in the table decreases spillway discharge, but increasing the exit slope from S does not increase discharge. If an exit slope (So) is steeper than S is used, then velocity (Vo) in the exit channel will increase according to the following relationship:

$$Vo = V(So/S)^{0.3}$$

Source: USDA - SCS

Figure 6-15.7

DESIGN DATA FOR EARTH SPILLWAYS

STAGE (Hg) IN FEET	SPILLWAY VARIABLES	BOTTOM WIDTH (b) IN FEET																
		8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
0.5	Q	6	7	8	10	11	13	14	15	17	18	20	21	22	24	25	27	28
	V	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
	S	3.9	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
0.6	Q	8	10	12	14	16	18	20	22	24	26	28	30	32	34	35	37	39
	V	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	S	3.7	3.7	3.7	3.7	3.6	3.7	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
0.7	Q	11	13	16	18	20	23	25	28	30	33	35	38	41	43	44	46	48
	V	3.2	3.2	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
	S	3.5	3.5	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
0.8	Q	13	16	19	22	26	29	32	35	38	42	45	46	48	51	54	57	60
	V	3.5	3.5	3.5	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
	S	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
0.9	Q	17	20	24	28	32	35	39	43	47	51	53	57	60	64	66	71	75
	V	3.7	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
	S	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
1.0	Q	20	24	29	33	38	42	47	51	56	61	63	68	72	77	81	86	90
	V	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	S	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
1.1	Q	23	28	34	39	44	49	54	60	65	70	74	79	84	89	95	100	105
	V	4.2	4.2	4.2	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
	S	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
1.2	Q	28	33	40	45	51	58	64	69	76	80	86	92	98	104	110	116	122
	V	4.4	4.4	4.4	4.4	4.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
	S	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
1.3	Q	32	38	46	53	58	65	73	80	86	91	99	106	112	119	125	133	140
	V	4.5	4.6	4.6	4.6	4.6	4.6	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
	S	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
1.4	Q	37	44	51	59	66	74	82	90	96	103	111	119	127	134	142	150	158
	V	4.7	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
	S	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
1.5	Q	41	50	58	66	75	85	92	101	108	116	125	133	142	150	160	169	178
	V	4.8	4.9	4.9	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.1	5.1	5.1
	S	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5
1.6	Q	46	56	65	75	84	94	104	112	122	132	142	149	158	168	178	187	197
	V	5.0	5.1	5.1	5.1	5.1	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
	S	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
1.7	Q	52	62	72	83	94	105	116	126	135	148	156	167	175	187	196	206	217
	V	5.2	5.2	5.2	5.3	5.3	5.3	5.3	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
	S	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
1.8	Q	58	68	81	93	104	116	127	138	150	160	171	182	194	204	214	226	233
	V	5.3	5.4	5.4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.6	5.6	5.6	5.6	5.6	5.6
	S	2.5	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
1.9	Q	64	76	88	102	114	127	140	152	164	175	188	201	213	225	235	248	260
	V	5.5	5.5	5.5	5.6	5.6	5.6	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
	S	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
2.0	Q	71	83	97	111	125	138	153	164	178	193	204	218	232	245	256	269	283
	V	5.6	5.7	5.7	5.7	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.9	5.9	5.9	5.9	5.9	5.9
	S	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
2.1	Q	77	91	107	122	135	149	162	177	192	207	220	234	250	267	276	291	305
	V	5.7	5.8	5.9	5.9	5.9	5.9	5.9	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
	S	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3

DATA TO RIGHT OF HEAVY VERTICAL LINES SHOULD BE USED WITH CAUTION, AS THE RESULTING SECTIONS WILL BE EITHER POORLY PROPORTIONED, OR HAVE VELOCITIES IN EXCESS OF 6 FEET PER SECOND.

Source: USDA-SCS

Table 6-15.5

PROCEDURE FOR DETERMINING OR ALTERING SEDIMENT BASIN SHAPE

As specified in the Standard and Specification, the pool area at the elevation of crest of the principal spillway shall have a length to width ratio of at least 2.0 to 1. The purpose of this requirement is to minimize the "short-circuiting" effect of the sediment laden inflow to the riser and thereby increasing the effectiveness of the sediment basin. The purpose of this procedure is to prescribe the parameters, procedures and methods of determining and modifying the shape of basin.

The length of the flow path *(L)* is the distance from the point of inflow to the riser (outflow point). The point of inflow is the point that the stream enters the normal pool (pool level at the riser crest elevation). The pool area *(A)* is the area of the normal pool. The effective width (W_e) is found by the equation:

$$W_e = \frac{A}{L} \text{ and L:W ratio} = \frac{L}{W_e}$$

In the event there is more than one inflow point, any inflow point which conveys more than 30 percent of the total peak inflow rate shall meet the length-width ratio criteria.

The required basin shape may be obtained by proper site selection, by excavation, or by constructing a baffle in the basin. The purpose of the baffle is to increase the effective flow length from the inflow point to the riser. Baffles shall be placed mid-way between the inflow point and the riser. The baffle length shall be as required to provide the minimum 2:1 length-width ratio. The effective length (L_e) shall be the shortest distance the water must flow from the inflow point around the end of the baffle to the outflow point. Then:

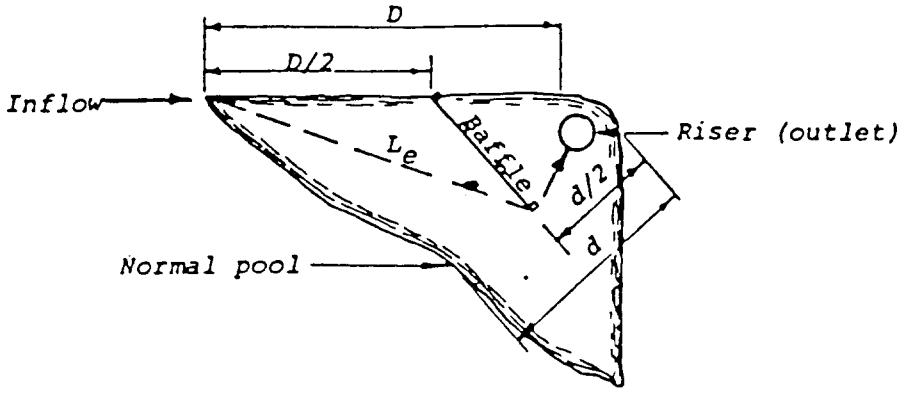
$$W_e = \frac{A}{L_e} \text{ and L:W ratio} = \frac{L_e}{W_e}$$

Three examples are shown on the following page. Note that for the special case in example C the water is allowed to go around both ends of the baffle and the effective length, $L_e = L_1 + L_2$. Otherwise, the length-width ratio computations are the same as shown above. This special case procedure for computing L_e is allowable only when the two flow paths are equal, i.e., when $L_1 = L_2$. A baffle detail is also shown.

SEDIMENT BASIN BAFFLES

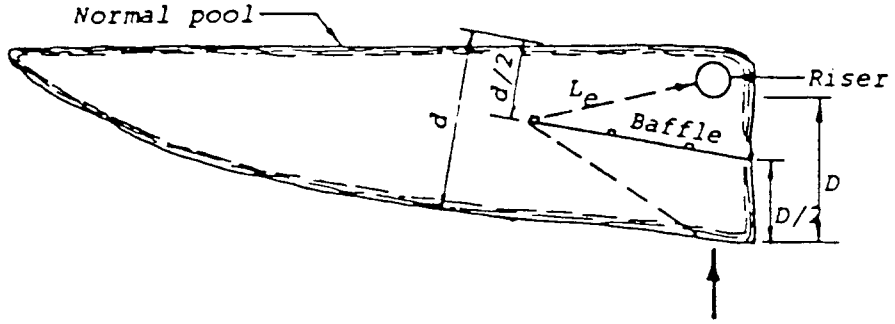
Examples: Plan Views - not to scale

A.

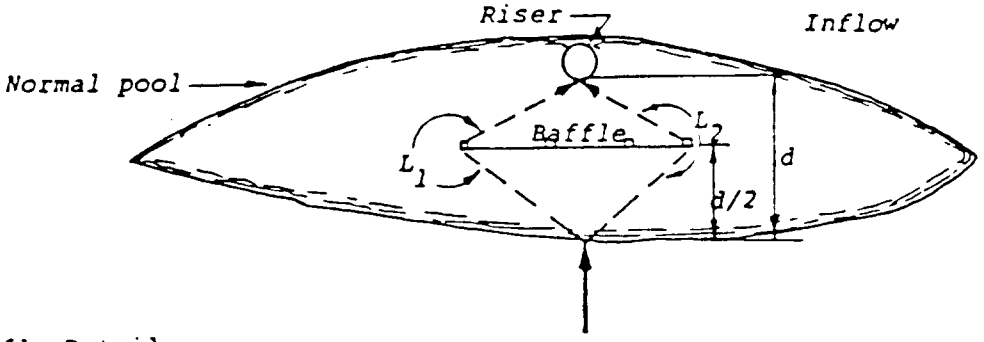


L_e = Total distance from the point of inflow around the baffle to the riser.

B.

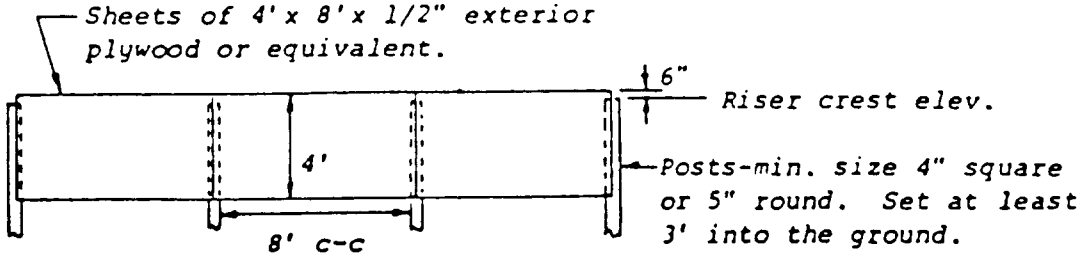


C.



$L_e = L_1 + L_2$

Baffle Detail

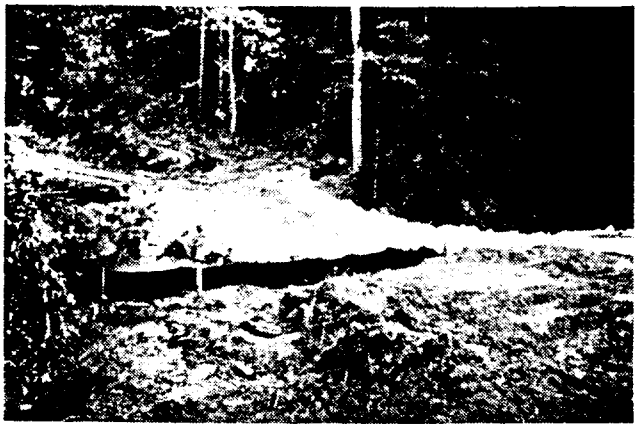


ELEVATION

Figure 6-15.8

Temporary Stream Crossing

Sr



DEFINITION

A *temporary* structure installed across a flowing stream or watercourse for use by construction equipment.

PURPOSE

This standard is used to protect streams from damage and erosion.

CONDITIONS

Structures may include bridges, round pipes or pipe arches. This standard does not apply to streams with drainage areas greater than one square mile. Very small streams may be crossed using armored, protected fords, such as rock riprap or logs.

DESIGN CRITERIA

Size

The structure shall be large enough to convey the full bank flow of the stream without appreciably altering the stream flow characteristic. Pipe openings may be obtained from the following table.

Overflow Protection

Structures shall be protected from washout during periods of peak discharges by diverting water around the structures. Methods to be considered for washout protection may include elevation of bridges above adjacent flood plain lands, crowning of fills over pipes, or by the use of diversions, dikes or island type structures. It is *desirable* that structures be designed to withstand flows from a 10-year frequency storm as determined by methods in Appendix A.

PIPE DIAMETERS FOR STREAM CROSSINGS[a]

Drainage Area (Acres)	Average Slope of Watershed 1%	4%	8%	16%
1-25	24	24	30	30
26-50	24	30	36	36
51-100	30	36	42	48
101-150	30	42	48	48
151-200	36	42	48	54
201-250	36	48	54	54
251-300	36	48	54	60
301-350	42	48	60	60
351-400	42	54	60	60
401-450	42	54	60	72
451-500	42	54	60	72
501-550	48	60	60	72
551-600	48	60	60	72
601-640	48	60	72	72

Table 6-16.1

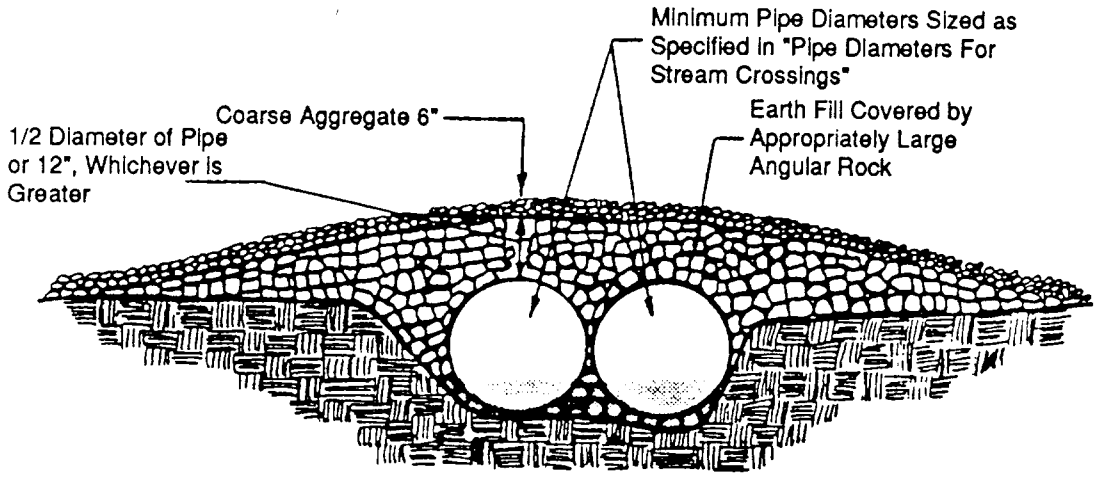
[a]Assumptions for determining the table: USDA-SCS Peak Discharge Method; CN = 65; Rainfall depth (average for Georgia) = 3.7" for 2-year frequency. Pipe diameters shown in the table are in inches.

Construction

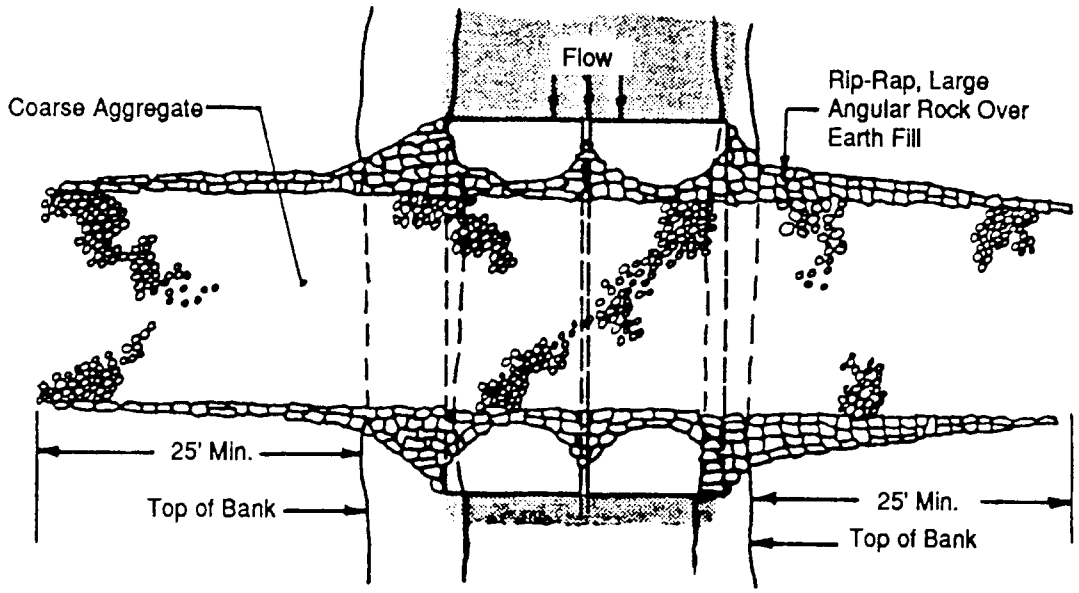
1. Clearing and excavation of the stream bed and banks shall be kept to a minimum.
2. The structure shall be removed as soon as it is no longer necessary for project construction.
3. Upon removal of the structure, the stream shall immediately be reshaped to its original cross-section and properly stabilized.

Maintenance

The structure shall be inspected after every rainfall and at least once a week, whether it has rained or not, and all damages repaired immediately.



ELEVATION



PLAN

GENERAL NOTES:

1. Not to scale.
2. This type of crossing can be installed in both a wet or dry weather stream condition where the drainage area exceeds 10 acres.
3. Remove during cleanup.

Figure 6-16.1

Storm Drain Outlet Protection

St

DEFINITION

Paved and/or riprapped channel sections, placed below storm drain outlets.

PURPOSE

To reduce velocity of flow before entering receiving channels below storm drain outlets.

CONDITIONS

This standard applies to all storm drain outlets, road culverts, paved channel outlets, etc., discharging into natural or constructed channels. Analysis and/or treatment will extend from the end of the conduit, channel or structure to the point of entry into an existing stream or publicly maintained drainage system.

DESIGN CRITERIA

Structurally lined aprons at the outlets of pipes and paved channel sections shall be designed according to the following criteria:

1. Capacity: 10-year, 24-hour peak runoff or the design discharge of the water conveyance structure, whichever is greater.
2. Tailwater depth: The depth of tailwater immediately below the pipe outlet must be determined for the design capacity of the pipe. Manning's Equation may be used to determine tailwater depth. If the tailwater depth is less than half the diameter of the outlet pipe, it shall be classified as a Minimum Tailwater Condition. If the tailwater depth is greater than half the pipe diameter, it shall be classified as a Maximum Tailwater Condition. Pipes which outlet onto flat areas with no defined channel may be assumed to have a Minimum Tailwater Condition.
3. Apron length: The apron length shall be determined from the curves according to the tailwater condition:
   Minimum Tailwater - Use Figure 6-17.3
   Maximum Tailwater - Use Figure 6-17.4
4. Apron width: If the pipe discharges directly into a well-defined channel, the apron shall extend across the channel bottom and up the channel banks to an elevation one foot above the maximum tailwater depth or to the top of the bank (whichever is less). If the pipe discharges onto a flat area with no defined channel, the width of the apron shall be determined as follows:
   a. The upstream end of the apron, adjacent to the pipe, shall have a width three times the diameter of the outlet pipe.
   b. For a Minimum Tailwater Condition, the down stream end of the apron shall have a width equal to three pipe diameters plus the length of the apron.
   c. For a Maximum Tailwater Condition, the down stream end shall have a width equal to three pipe diameters plus 0.4 times the length of the apron.
5. Bottom grade: The apron shall be constructed with no slope along its length (0.0% grade). The invert elevation of the downstream end of the apron shall be equal to the elevation of the invert of the receiving channel. There shall be no overfall at the end of the apron.
6. Side slope: If the pipe discharges into a well-defined channel, the side slopes of the channel shall not be steeper than 2:1 (Horizontal: Vertical).
7. Alignment: The apron shall be located so that there are no bends in the horizontal alignment.
8. Materials: The apron may be lined with riprap, grouted riprap, or concrete. The median sized stone for riprap, d_{50}, shall be determined from the curves, Figures 6-17.3 and 6-17.4, according to the tailwater condition. The gradation, quality and placement of riprap shall conform to Appendix C.

CONSTRUCTION SPECIFICATIONS

1. Ensure that the subgrade for the filter and riprap follows the required lines and grades shown in the plan. Compact any fill required in the subgrade to the density of the surrounding undisturbed material. Low areas in the subgrade on undisturbed soil may also be filled by increasing the riprap thickness.
2. The riprap and gravel filter must conform to the specified grading limits shown on the plans.
3. Filter fabric, when used, must meet design requirements and be properly protected from punching or tearing during installation. Repair any damage by removing the riprap and placing another piece of filter fabric over the damaged area. All connecting joints should overlap a minimum of 1 ft. If the damage is extensive, replace the entire filter fabric.
4. Riprap may be placed by equipment, but take care to avoid damaging the filter.
5. The minimum thickness of the riprap should be 1.5 times the maximum stone diameter.
6. Riprap may be field stone or rough quarry stone. It should be hard, angular, highly weather-resistant and well graded.
7. Construct the apron on zero grade with no overfall at the end. Make the top of the riprap at the downstream end level with the receiving area or slightly below it.
8. Ensure that the apron is properly aligned with the receiving stream and preferably straight throughout its length. If a curve is needed to fit site conditions, place it in the upper section of the apron.
9. Immediately after construction, stabilize all disturbed areas with vegetation.
10. Stone quality - Select stone for riprap from field stone or quarry stone. The stone should be hard, angular, and highly weather-resistant. The specific gravity of the individual stones should be at least 2.5.
11. Filter - Install a filter to prevent soil movement through the openings in the riprap. The filter should consist of a graded gravel layer or a synthetic filter cloth. See Appendix C; p. C-1.

MAINTENANCE

Inspect riprap outlet structures after heavy rains to see if any erosion around or below the riprap has taken place or if stones have been dislodged. Immediately make all needed repairs to prevent further damage.

Riprap (large stones of various sizes) is often used to prevent erosion at the ends of culverts and other pipe conduits. It converts high-velocity, concentrated pipe flow into low-velocity, open channel flow. Stone should be sized and the apron shaped to protect receiving channels from erosion caused by maximum pipe exit velocities.

Several methods are available for designing riprap outlet structures. The method presented in this section is adapted from procedures used by the USDA Soil Conservation Service. Outlet protection is provided by a level apron of sufficient length and flare to reduce flow velocities to non-erosive levels.

The following procedure uses two sets of design curves: Figure 6-17.3 is used for minimum tailwater conditions and Figure 6-17.4 for maximum tailwater conditions.

Step 1. Determine the tailwater depth from channel characteristics below the pipe outlet for the design capacity of the pipe. If the tailwater depth is less than half the outlet pipe diameter, it is classified minimum tailwater condition. If it is greater than half the pipe diameter, it is classified maximum tailwater condition. Pipes that outlet onto wide flat areas with no defined channel are assumed to have a minimum tailwater condition unless reliable flood stage elevations show otherwise.

Step 2. Based on the tailwater conditions determined in Step 1, enter Figure 6.17.3 or Figure 6-17.4 and determine d_{50} riprap size and minimum apron length (La). The d_{50} size is the median stone size in a well-graded riprap apron.

Step 3. Determine apron width at the pipe outlet, the apron shape, and the apron width at the outlet end from the same figure used in Step 2.

Step 4. Determine the maximum stone diameter:

$$d_{max} = 1.5 \times d_{50}$$

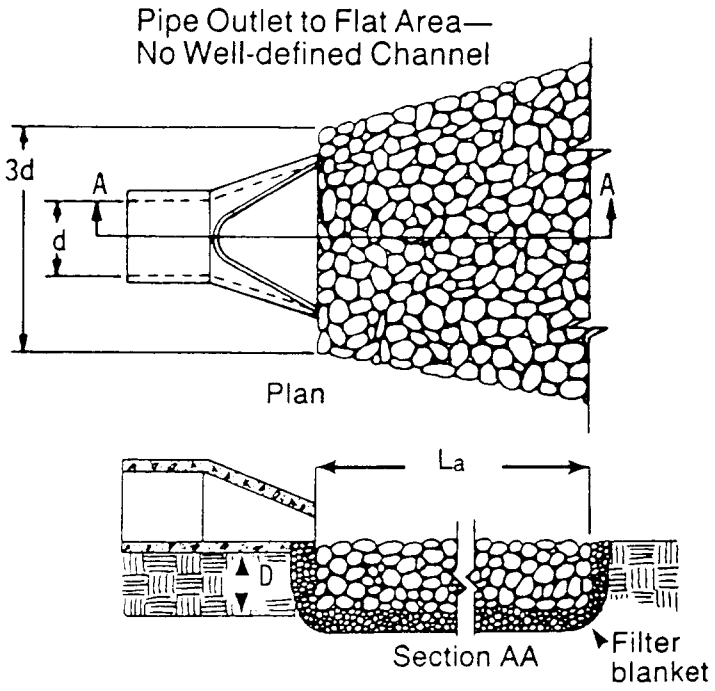
Step 5. Determine the apron thickness:

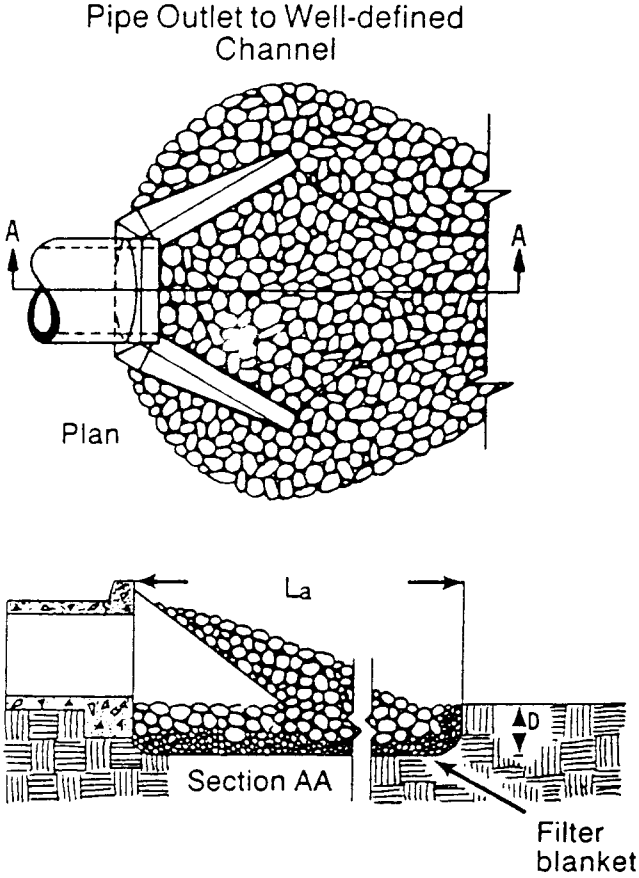
$$\text{Apron thickness} = 1.5 \times d_{max}$$

The apron thickness may be reduced to $1.5 \times d_{50}$ when an appropriate filter fabric is used under the apron.

Step 6. Fit the riprap apron to the site by making it level for the minimum length, L_a from Figure 6-17.3 or Figure 6-17.4. Extend the apron farther downstream and along channel banks until stability is assured. Keep the apron as straight as possible and align it with the flow of the receiving stream. Make any necessary alignment bend near the pipe outlet so that the entrance into the receiving stream is straight.

Some locations may require lining of the entire channel cross section to assure stability.



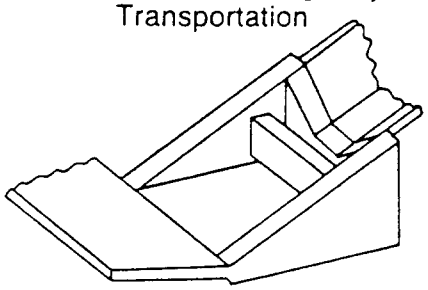


Notes

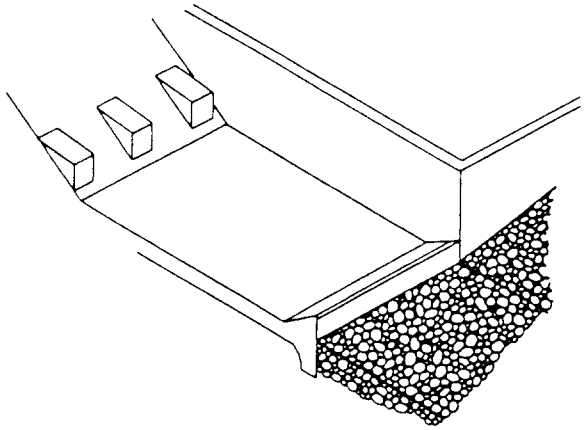
1. L_a is the length of the riprap apron.
2. D = 1.5 times the maximum stone diameter but not less than 6".
3. In a well-defined channel extend the apron up the channel banks to an elevation of 6" above the maximum tailwater depth or to the top of the bank, whichever is less.
4. A filter blanket or filter fabric should be installed between the riprap and soil foundation.

Figure 6-17.1 Riprap outlet protection (modified from Va SWCC).

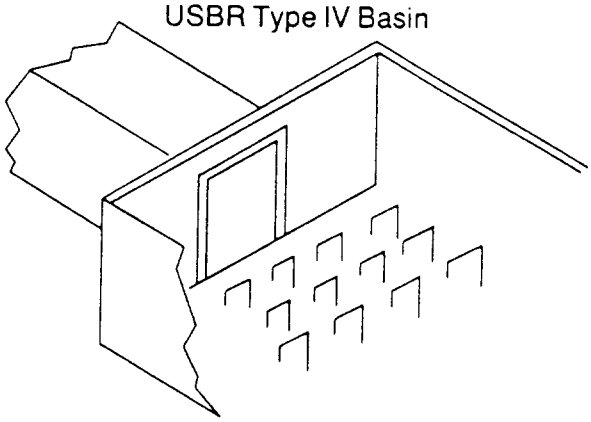
Virginia Department of Highways and Transportation



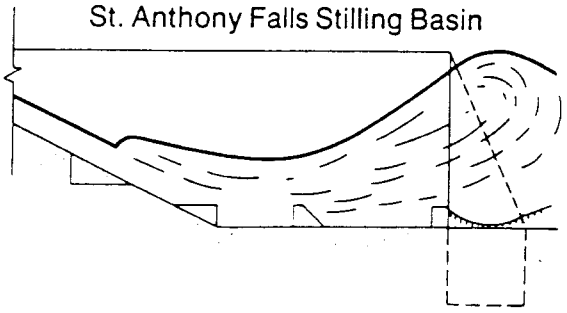
Colorado State University Rigid Boundary Basin



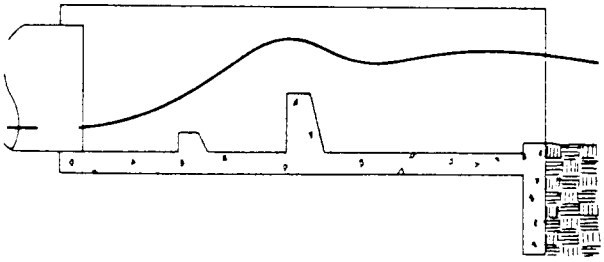
USBR Type IV Basin



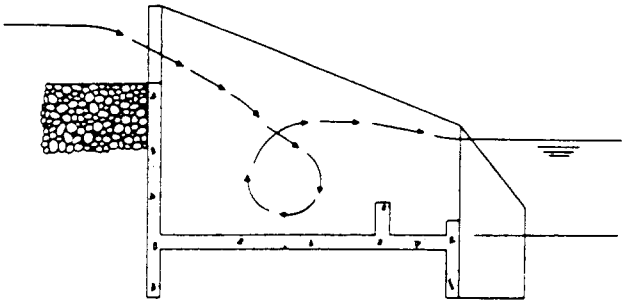
St. Anthony Falls Stilling Basin



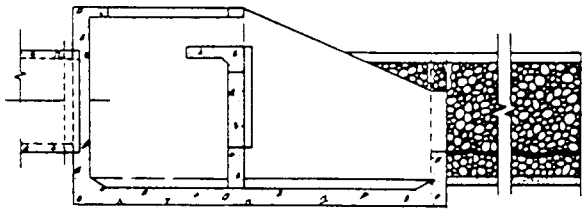
Contra Costa County, Calif.



Straight Drop Spillway Stilling Basin



USBR Type VI Baffle Wall Basin

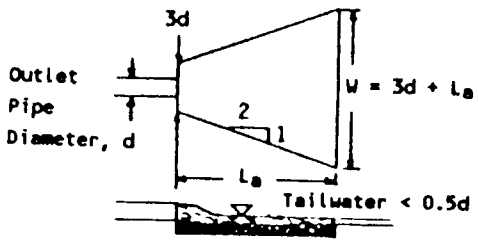


T-fitting on CMP Outlet

Figure 6-17.2 Alternative structures for energy dissipation at an outlet (modified from Goldman, Jackson, and Bursztynsky).

Source: USDA-SCS

DESIGN OF OUTLET PROTECTION FROM A ROUND PIPE FLOWING FULL
MINIMUM TAILWATER CONDITION (T_w < 0.5 DIAMETER)



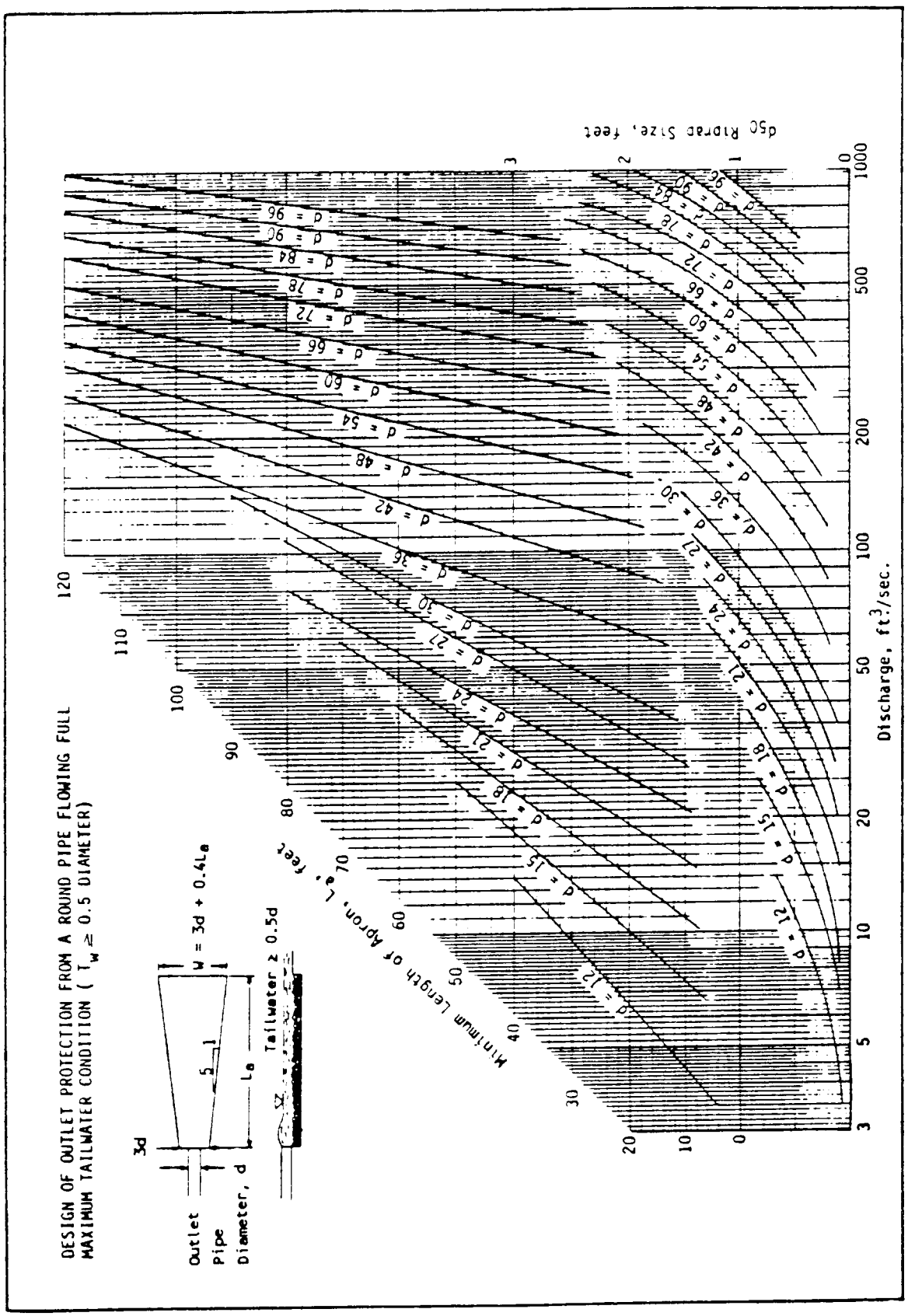
EXAMPLE:

Given: Discharge = 50 cfs, d = 30"

Find: d_{50} Riprap size, L_a and W

Solution: d_{50} = 0.7'; use d_{50} = 9"
L_a = 22'
W = 3d + L_a = 3(2.5) + 22 = 29.5 ft.

Figure 6-17.3

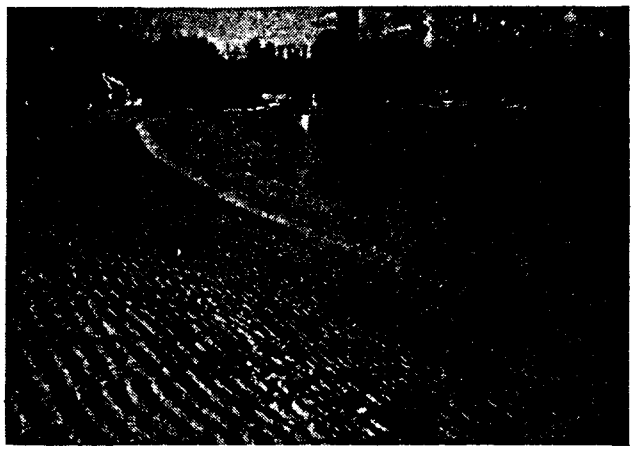


Source: USDA-SCS

Figure 6-17.4

Surface Roughening

Su



DEFINITION

Providing a rough soil surface with horizontal depressions created by operating a tillage or other suitable implement on the contour, or by leaving slopes in a roughened condition by not fine-grading them.

PURPOSE

The purposes of surface roughening are to aid in establishment of vegetative cover with seed, to reduce runoff velocity and increase infiltration and to reduce erosion and provide for sediment trapping.

CONDITIONS

All slopes steeper than 3:1 require surface roughening, either stair-step grading, grooving, furrowing, or tracking if they are to be stabilized with vegetation.

Areas with grades less steep than 3:1 should have the soil surface lightly roughened and loosened to a depth of 2 to 4 inches prior to seeding. Areas which have been graded and will not be stabilized immediately may be roughened to reduce runoff velocity until seeding takes place. Slopes with a stable rock face do not require roughening or stabilization.

DESIGN CRITERIA

Graded areas with smooth, hard surfaces give a false impression of "finished grading" and a job well done. It is difficult to establish vegetation on such surfaces due to reduced water infiltration and the potential for erosion. Rough slope surfaces with uneven soil and rocks left in place may appear unattractive or unfinished at first, but encourage water infiltration, speed the establishment of vegetation, and decrease runoff velocity.

Rough, loose soil surfaces give lime, fertilizer and seed some natural coverage. Niches in the surface provide microclimates which generally provide a cooler and more favorable moisture level than hard flat surfaces. This aids seed germination.

There are different methods of achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

1. Disturbed areas which will not require mowing may be stair-step graded, grooved, or left rough after filling.
2. Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material which sloughs from above, and provides a level site where vegetation can become established.
3. Areas which will be mowed (these areas should have slopes less steep than 3:1) may have small furrows left by discing, harrowing, raking, or seed planting machinery operated on the contour.
4. It is important to avoid excessive compacting of the soil surface when scarifying. Tracking with bulldozer treads is preferable to not roughening at all, but is not as effective as other forms of roughening, as the soil surface is severely compacted and runoff is increased.

CONSTRUCTION SPECIFICATIONS

Cut slopes with a gradient steeper than 3:1 shall be stair-step graded or grooved (see Figure 6-18.1).

1. Stair step grading may be carried out on any material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading.

The ratio of the vertical cut distance to the horizontal distance shall be less than 1:1 and the horizontal portion of the "step" shall slope toward the vertical wall.

Individual vertical cuts shall not be more than 30 inches on soft soil materials and not more than 40 inches in rocky materials.

2. Grooving consists of using machinery to create a series of ridges and depressions which run perpendicular to the slope (on the contour).

Grooves may be made with any appropriate implement which can be safely operated on the slope and which will not cause undue compaction. Suggested implements include discs, tillers, spring harrows, and the teeth on a front-end loader bucket. Such grooves shall not be less than 3 inches deep nor further than 15 inches apart.

Fill Slope Applications For Areas Which Will Not Be Mowed

Fill slopes with a gradient steeper than 3:1 shall be grooved or allowed to remain rough as they are constructed. Method (1) or (2) below may be used.

1. Groove according to #2 above.
2. As lifts of the fill are constructed, soil and rock materials may be allowed to fall naturally onto the slope surface (see Figure 6-18.1).

Colluvial materials (soil deposits at the base of slopes or from old stream beds) shall not be used in fills as they flow when saturated.

Cuts, Fills, and Graded Areas Which Will Be Mowed

Mowed slopes should not be steeper than 3:1. Excessive roughness is undesirable where mowing is planned.

These areas may be roughened with shallow grooves such as remain after tilling, discing, harrowing, raking, or use of a cultipacker-seeder. The final pass of any such tillage implement shall be on the contour (perpendicular to the slope).

Grooves formed by such implements shall be not less than one inch deep and not further than 12 inches apart.

Fill slopes which are left rough as constructed may be smoothed with a dragline or pickchain to facilitate mowing.

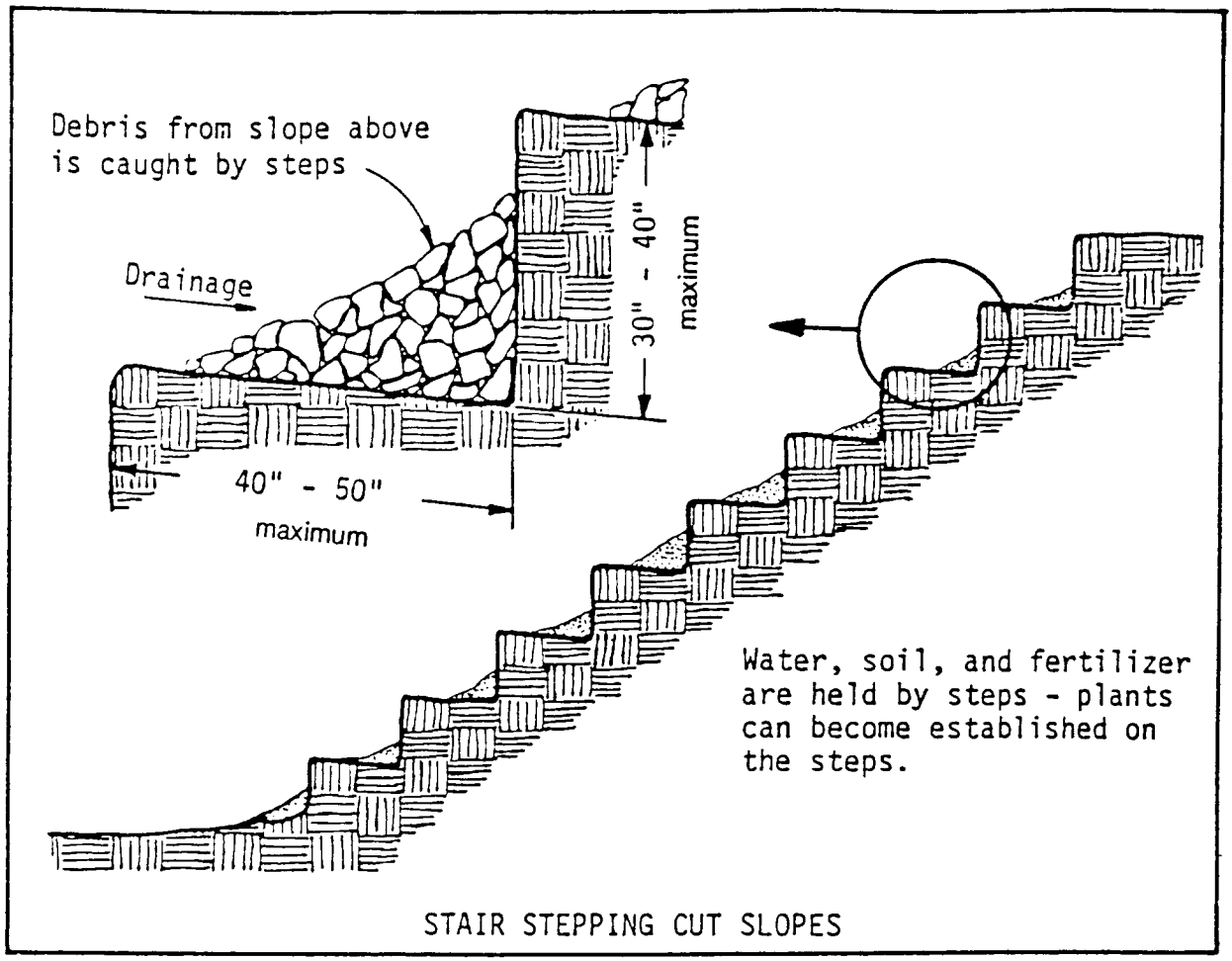
Roughening With Tracked Machinery

Roughening with tracked machinery on clayey soils is not recommended unless no alternatives are available. Undue compaction of surface soil results from this practice. Sandy soils do not compact severely and may be tracked. In no case is tracking as effective as the other roughening methods described.

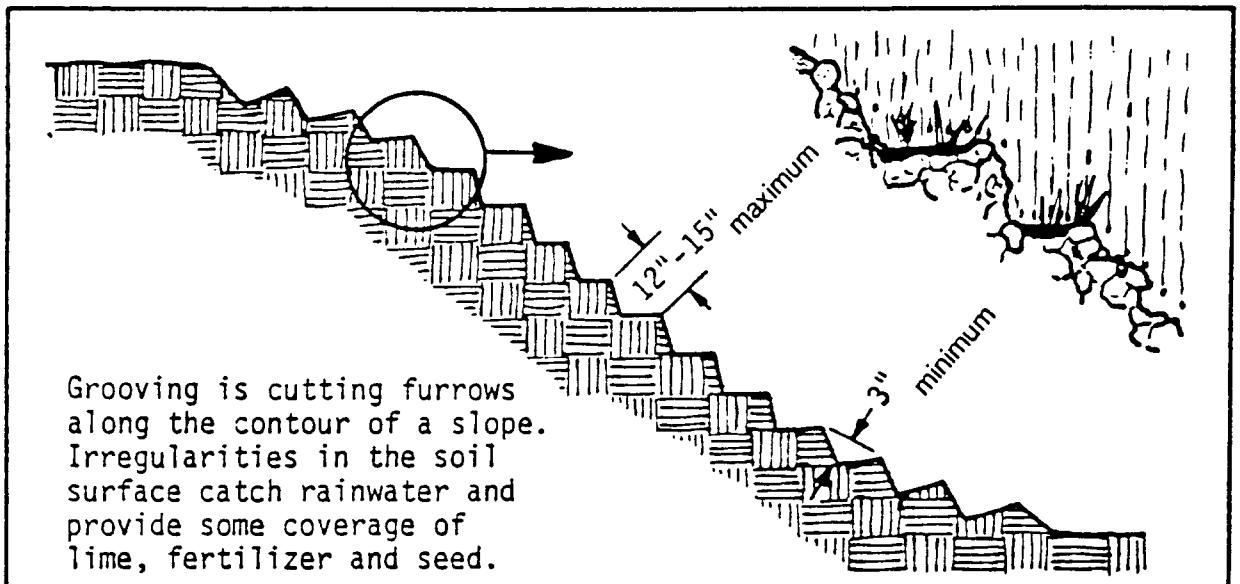
When tracking is the chosen surface roughening technique, it shall be done by operating tracked machinery up and down the slope to leave horizontal depressions in the soil. As few passes of the machinery as possible should be made to minimize compaction.

Seeding

Roughened areas shall be seeded and mulched as soon as possible to obtain optimum seed germination and seedling growth.

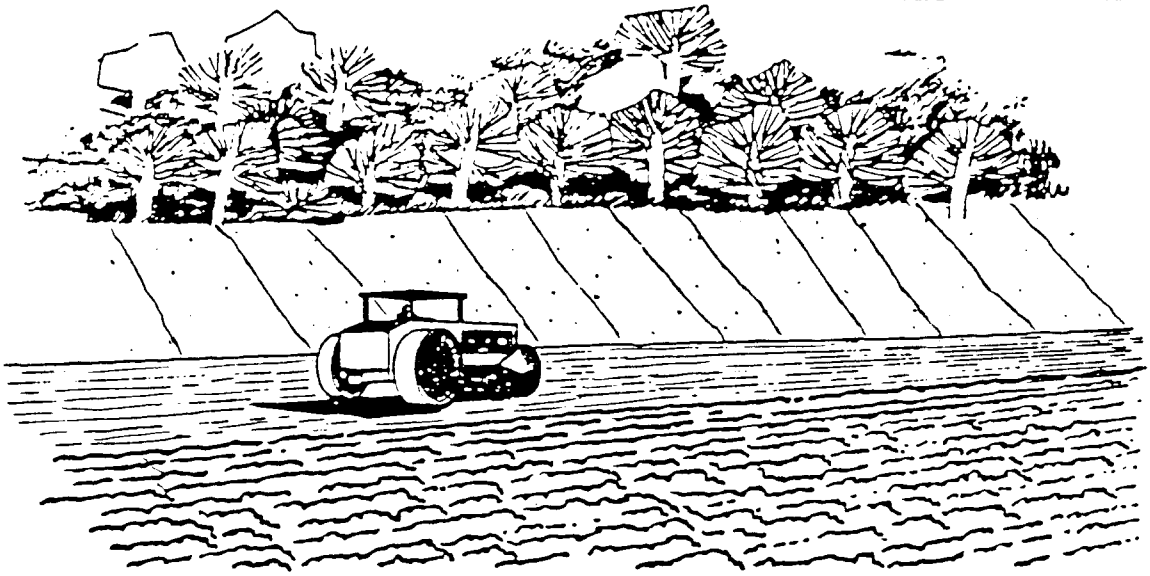


STAIR STEPPING CUT SLOPES



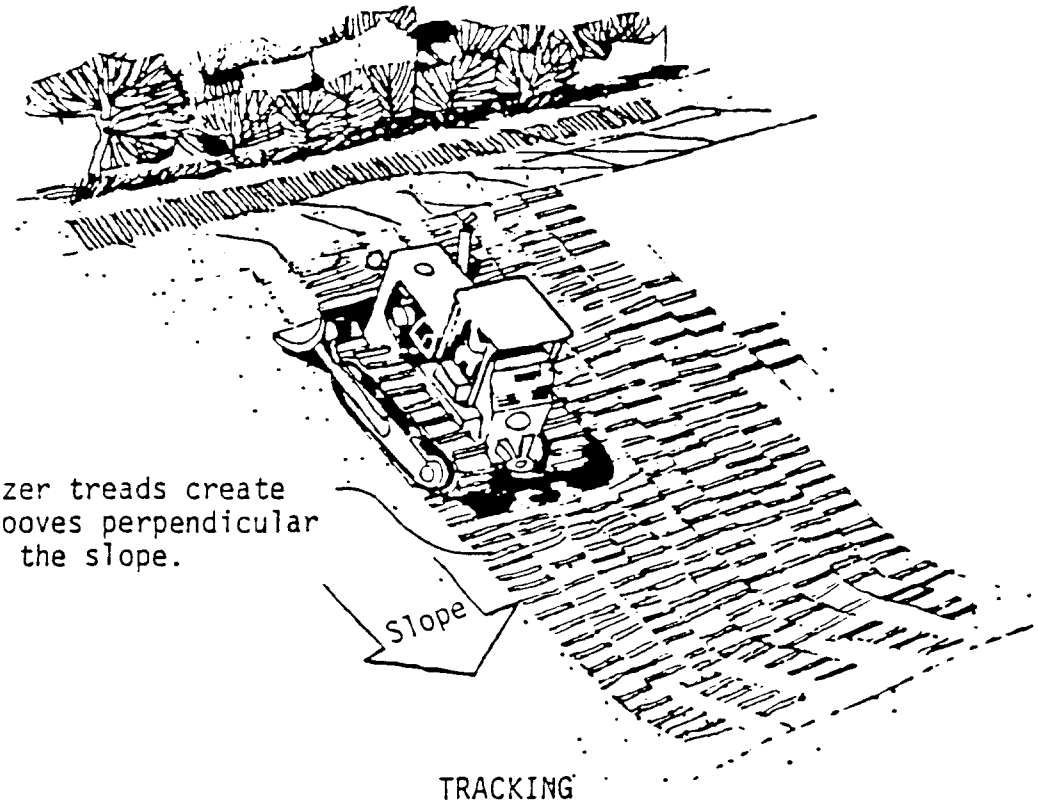
GROOVING SLOPES

Figure 6-18.1



Each lift of the fill is compacted, but the outer face of the slope is allowed to remain loose so that the rocks, clods, etc. reach the natural angle of repose.

FILL SLOPE TREATMENT



TRACKING

Figure 6-18.2

Topsoiling

Tp

DEFINITION

Stripping off the more fertile top soil, storing it, then spreading it over the disturbed area after completion of construction activities.

PURPOSE

To provide a suitable soil medium for vegetative growth on areas where other measures will not produce or maintain a desirable stand.

CONDITIONS

This practice is recommended for sites of 2:1 or flatter slopes where:

— The texture of the exposed subsoil or parent material is not suitable to produce adequate vegetative growth.
— The soil material is so shallow that the rooting zone is not deep enough to support plants with continuing supplies of moisture and food.
— The soil to be vegetated contains material toxic to plant growth.

SPECIFICATIONS

Materials

Topsoil should be friable and loamy, free of debris, objectionable weeds and stones and contain no toxic substance that may be harmful to plant growth. A pH range of 5.0-7.5 is acceptable. Soluble salts should not exceed 500 ppm.

Testing

Field exploration should be made to determine whether the quantity and quality of surface soil justifies stripping.

Stripping

Stripping should be confined to the immediate construction area.

A 4 to 6 inch stripping depth is common, but may vary depending on the particular soil.

Topsoil pH

If pH value is less than 6.0, lime shall be applied and incorporated with the topsoil to adjust the pH to 6.5 or higher. Topsoils containing soluble salts greater than 500 parts per million shall not be used.

Stockpiles

The location of topsoil stockpiles should not obstruct natural drainage or cause off-site environmental damage.

Stockpiles may be vegetated in accordance with the appropriate standards and specifications.

Site Preparation (Where topsoil is to be added)

Topsoiling. When topsoiling, maintain needed erosion control practices such as diversions, grade stabilization structures, berms, dikes, level spreaders, waterways, sediment basins, etc.

Grading. Grades on the areas to be topsoiled which have been previously established shall be maintained.

Liming. Where the pH of the subsoil is 5.0 or less or composed of heavy clays, agricultural limestone shall be spread at the rate of 100 pounds per 1,000 square feet. Lime shall be distributed uniformly over designated areas and worked into the soil in conjunction with tillage operations as described in the following procedure.

Bonding. Use one of the following methods to insure bonding of topsoil and subsoil:

1. **Tilling.** After the areas to be topsoiled have been brought to grade, and immediately prior to dumping and spreading the topsoil, the subgrade shall be loosened by discing or scarifying to a depth of at least 3 inches to permit bonding of the topsoil to the subsoil.
2. **Tracking.** Passing a bulldozer over the entire surface area of the slope to leave tracks vertically or diagonally.

Applying Topsoil

A. Topsoil should be handled only when it is dry enough to work without damaging soil structure.

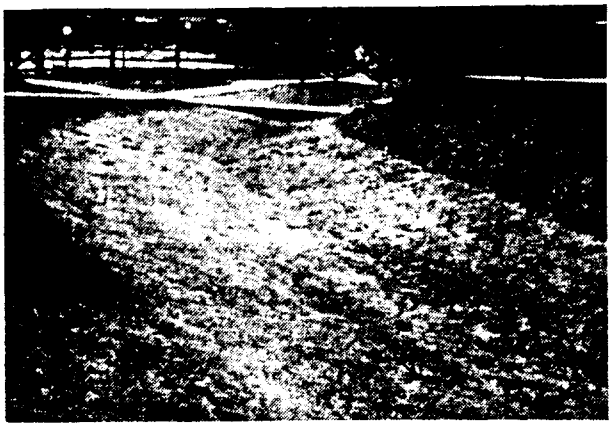
B. A uniform application of 5 inches (unsettled) is recommended, but may be adjusted at the discretion of the engineer or landscape architect.

Cubic Yards Of Topsoil Required For Application To Various Depths

Depth (Inches)	Per 1,000 Square Feet	Per Acre
1	3.1	134
2	6.2	268
3	9.3	403
4	12.4	537
5	15.5	672
6	18.6	806

Vegetated Waterway or Stormwater Conveyance Channel

Wt



DEFINITION

A natural or constructed channel that is shaped or graded to required dimensions and established in suitable vegetation for the stable conveyance of runoff.

PURPOSE

To dispose of runoff without causing damage either by erosion or by flooding.

CONDITIONS

This standard applies to all sites where added channel capacity and/or stabilization is required to control erosion resulting from concentrated runoff and where such control can be achieved by this practice alone or in combination with others.

DESIGN CRITERIA

Capacity

The minimum capacity shall be that required to convey the peak runoff expected from a ten-year, 24-hour storm. Peak runoff values used in determining the capacity requirements shall be as outlined in Appendix A or by other accepted methods.

The design of a waterway is based on the determination of channel dimensions that will carry the estimated flow without damage to the channel or its lining. Vegetative linings vary in their protective ability according to type and density. Therefore, safe velocities under various conditions are a matter for careful consideration.

Velocity

In designing grassed waterways, care must be taken to ensure that the design velocity is well within the limits of permissible velocities given in Table 6-20.1. These values apply to uniform good stands of each type of cover.

Cross Section

The minimum design capacity of a waterway receiving water from developing areas, diversions, or other tributary channels shall be that depth required to keep the design water surface elevation in the channel to prevent overflow.

The bottom width of waterways or outlets shall not exceed 50 feet unless multiple or divided waterways or other means are provided to control meandering of low flows within this limit.

Drainage

Tile or other suitable subsurface drainage measures shall be provided for sites having high water tables or seepage problems. Where there is base flow, a stone center or lined channel will be required. See Appendix C for rock riprap specifications.

Stone Center

Stone center waterways shall be constructed as shown in Figure 6-20.2 and Table 6-20.3 and stabilized with riprap according to riprap specifications, Appendix C.

Vegetative Retardance Factor

The design of a vegetated waterway is more complicated than for a bare channel since the value for n" varies where grass linings are used. Tests show that vegetation tends to bend and oscillate under the influence of velocity and depth of flow. Thus the retardance to flow varies as these factors change.

Five general retardance curves designated as A, B, C, D, and E have been developed for various cover conditions. The vegetal conditions under which the various retardance values apply in Georgia are shown in Table 6-20.1. These cover classifications are based on tests in experimental channels when the covers were green and generally uniform.

The following example demonstrates how to use the tables to design a parabolic channel:

Problem:

Determine the safe velocity and dimensions for stability and capacity for a waterway with parabolic cross section.

Given:

Runoff	Q = 55 c.f.s
Grade	= 6 percent
Vegetative Cover	= Bermudagrass

Conditions of Vegetation:

Good Stand Not Mowed	= "B" curve retardance (from Table 6-20.1)
Good Stand Mowed 2.5"	= "D" curve retardance (from Table 6-20.1)
Maximum Permissible Velocity, V_1	= 5.0 f.p.s. (from Table 6-20.1)

Horizontally opposite 55 c.f.s. in Table 6-20.2 (6 percent slope) in the column headed V_1 = 5.0 f.p.s., find T = 27.1 feet, D = 1.04 feet and V_2 = 2.89 f.p.s. Therefore, a waterway with parabolic cross section, a top width of 27.1 feet, and a depth of 1.04 feet will carry 55 c.f.s. at a maximum velocity of 5 feet per second when the vegetative lining is short (2.5") in height and 2.89 feet per second when the vegetative lining is tall. This complies with requirements for safe velocity when vegetation is short ("D" retardance) and capacity when vegetation is tall ("B" retardance).

The dimensions given by Table 6-20.2 are the minimums required to carry the actual flow. These tables do not include a factor for extra depth required for space occupied by vegetation and sedimentation.

Figure 6-20.1 shows typical cross sections for parabolic and trapezoidal waterways.

Stone center waterways are shown in Figure 6-20.2. Velocity, top width, and depth for parabolic stone center waterways are given in Table 6-20.3. Figure 6-20.3 may be used for sizing rocks for waterways.

CONSTRUCTION SPECIFICATIONS

1. All trees, brush, stumps, obstructions, and other objectionable material shall be removed and disposed of so as not to interfere with the proper functioning of the waterway.
2. The waterway or outlet shall be excavated or shaped to line, grade, and cross section as required to meet the criteria specified herein. It will be free of bank projections or other irregularities which will impede normal flow.
3. Fills shall be compacted as needed to prevent unequal settlement that would cause damage in the completed waterway.
4. All earth removed and not needed in construction shall be spread or disposed of so that it will not interfere with waterway functioning.
5. Stabilization:

Applicable vegetative standards shall be followed for time of seeding, sprigging or sodding, liming and fertilizing, and site and seedbed preparation.

Mulching shall be a requirement for all seeded or sprigged channels and shall be performed according to standard and specification Dsl - Disturbed Area Stabilization (With Mulching Only).

Temporary protection during establishment should be provided when conditions permit through temporary diversions or other means to dispose of water.

Erosion control fabrics which are designed to protect seed and slopes during the establishment of vegetation may also be used. These fabrics hold seed and soil in place to prevent erosion while the seed is germinating and until a vegetative cover becomes established. The fabric is constructed from a natural fiber which is bio-degradable. In decomposing, it also adds organic matter to the soil. Installation methods should follow manufacturer recommendations.

VEGETATIVE COVER TYPE	GOOD STAND				MAXIMUM PERMISSIBLE VELOCITY, V_1, FEET PER SECOND
	FOR CAPACITY AND V_2		FOR STABILITY AND V_1		
	RETARDANCE	PLANT HT. NOT MOWED	RETARDANCE	PLANT HT. MOWED	
BERMUDAGRASS	B	12"	D	2-6"	5
BAHIA	C	6-12"	D	2-6"	4
TALL FESCUE GRASS MIXTURES[1]	B	18"	D	6"	4
SERICEA LESPEDEZA WEEPING LOVEGRASS	B	19"	D	2-6"	3
STONE CENTER	RIPRAP STONE SIZE CAN BE DETERMINED IN APPENDIX C.				

Permissible Velocities and Retardances for Vegetated and Rock-Lined Waterways

Table 6-20.1

[1]mixtures of Tall Fescue, Bahia, and/or Bermuda

NOTE: For planting instructions, refer to Disturbed Area Stabilization (With Permanent Vegetation) Ds3, page 6-167.

V_1 for RETARDANCE "D". Top Width (T), Depth (D) and V_2 for RETARDANCE "B".

Grade 0.50 Percent

Q cfs	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	10.2	2.28	0.95																							
20	13.3	2.18	1.02																							
25	16.5	2.15	1.05	10.5	2.60	1.35																				
30	19.7	2.12	1.06	12.4	2.51	1.42	9.5	2.91	1.60																	
35	22.8	2.09	1.09	14.3	2.45	1.48	10.9	2.81	1.69																	
40	26.0	2.08	1.09	16.3	2.44	1.49	12.3	2.74	1.76																	
45	29.2	2.08	1.10	18.2	2.41	1.52	13.7	2.69	1.81																	
50	32.4	2.08	1.10	20.2	2.40	1.53	15.1	2.64	1.86	11.1	3.22	2.07														
55	35.6	2.08	1.11	22.1	2.38	1.55	16.6	2.64	1.86	12.0	3.11	2.18														
60	38.8	2.08	1.11	24.1	2.38	1.55	18.0	2.61	1.90	13.0	3.07	2.23														
65	42.0	2.08	1.11	26.0	2.36	1.57	19.5	2.61	1.89	14.0	3.03	2.27														
70	45.2	2.08	1.11	28.0	2.36	1.57	20.9	2.59	1.92	15.0	3.01	2.31														
75	48.4	2.08	1.11	29.9	2.35	1.59	22.4	2.59	1.92	16.0	2.98	2.34	12.7	3.48	2.52											
80	51.6	2.08	1.11	31.9	2.36	1.58	23.8	2.58	1.94	17.0	2.96	2.36	13.4	3.41	2.60											
90	57.9	2.07	1.12	35.8	2.35	1.59	26.7	2.56	1.96	19.1	2.95	2.37	15.0	3.37	2.64											
100	64.3	2.07	1.11	39.7	2.34	1.60	29.6	2.55	1.97	21.1	2.92	2.42	16.5	3.31	2.72	13.3	3.77	2.96								
110	70.7	2.08	1.11	43.6	2.34	1.61	32.6	2.56	1.96	23.2	2.92	2.42	18.1	3.29	2.75	14.5	3.70	3.05								
120	77.0	2.07	1.12	47.5	2.33	1.61	35.5	2.56	1.97	25.2	2.89	2.45	19.6	3.24	2.81	15.7	3.64	3.12								
130	83.4	2.08	1.12	51.5	2.34	1.61	38.4	2.55	1.98	27.3	2.90	2.45	21.2	3.23	2.82	16.9	3.60	3.18								
140	89.7	2.08	1.12	55.4	2.34	1.61	41.3	2.55	1.98	29.3	2.88	2.47	22.8	3.22	2.84	18.1	3.56	3.23								
150	96.0	2.08	1.12	59.3	2.34	1.61	44.2	2.55	1.99	31.4	2.88	2.47	24.3	3.19	2.88	19.4	3.56	3.23	15.5	4.09	3.52					
160	102.3	2.08	1.12	63.2	2.34	1.61	47.1	2.54	1.99	33.5	2.89	2.47	25.9	3.19	2.88	20.6	3.53	3.27	16.4	4.02	3.60					
170	108.6	2.08	1.12	67.1	2.34	1.62	50.0	2.54	1.99	35.5	2.87	2.48	27.5	3.19	2.89	21.9	3.54	3.27	17.4	4.01	3.62					
180	114.9	2.08	1.12	70.9	2.33	1.62	52.9	2.54	1.99	37.6	2.88	2.48	29.1	3.19	2.89	23.1	3.51	3.30	18.3	3.96	3.69					
190	121.2	2.08	1.12	74.8	2.33	1.62	55.8	2.54	2.00	39.6	2.87	2.49	30.6	3.16	2.92	24.3	3.49	3.34	19.3	3.96	3.70					
200	127.4	2.08	1.13	78.7	2.33	1.62	58.7	2.54	2.00	41.7	2.87	2.49	32.2	3.16	2.93	25.6	3.50	3.33	20.2	3.91	3.77	16.8	4.48	3.96		
220	140.0	2.08	1.13	86.5	2.33	1.62	64.5	2.54	2.00	45.8	2.87	2.50	35.4	3.16	2.93	28.1	3.49	3.35	22.1	3.87	3.83	18.3	4.39	4.08		
240	152.6	2.08	1.13	94.3	2.33	1.63	70.3	2.54	2.01	49.9	2.86	2.51	38.6	3.16	2.93	30.6	3.48	3.36	24.1	3.87	3.84	19.9	4.36	4.12		
260	165.2	2.08	1.13	102.1	2.33	1.63	76.1	2.54	2.01	54.0	2.86	2.51	41.7	3.15	2.95	33.1	3.47	3.38	26.0	3.84	3.88	21.5	4.34	4.15		
280	177.7	2.08	1.13	109.8	2.33	1.63	81.9	2.54	2.01	58.2	2.87	2.50	44.9	3.15	2.95	35.6	3.46	3.39	28.0	3.84	3.88	23.0	4.28	4.24	19.0	4.88	4.50
300	190.3	2.08	1.13	117.6	2.33	1.63	87.7	2.54	2.01	62.3	2.86	2.51	48.0	3.14	2.97	38.1	3.45	3.40	29.9	3.82	3.92	24.6	4.27	4.26	20.2	4.80	4.61

Table 6-20.2 - Parabolic waterway design
(Retardance "D" and "B")

V_1 for RETARDANCE "D". Top Width (T), Depth (D) and V_2 for RETARDANCE "B".

Grade 1.0 Percent

Q cfs	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	15.7	1.55	0.91	9.9	1.80	1.24																				
20	20.9	1.54	0.92	13.0	1.74	1.31	8.8	2.04	1.65																	
25	26.0	1.53	0.93	16.2	1.73	1.32	10.9	1.99	1.70	8.9	2.21	1.87														
30	31.1	1.52	0.94	19.3	1.70	1.35	12.9	1.94	1.78	10.5	2.14	1.98														
35	36.2	1.52	0.94	22.5	1.70	1.36	15.0	1.93	1.80	12.1	2.08	2.06	9.2	2.37	2.37											
40	41.3	1.52	0.95	25.7	1.70	1.36	17.1	1.92	1.81	13.7	2.04	2.12	10.4	2.32	2.45											
45	46.4	1.52	0.95	28.8	1.69	1.37	19.2	1.91	1.82	15.4	2.04	2.12	11.7	2.32	2.46											
50	51.5	1.52	0.95	32.0	1.70	1.37	21.2	1.89	1.85	17.0	2.02	2.16	12.9	2.28	2.52	9.9	2.61	2.86								
55	56.5	1.51	0.95	35.1	1.69	1.38	23.3	1.89	1.86	18.7	2.02	2.16	14.1	2.25	2.57	10.8	2.57	2.93								
60	61.6	1.52	0.95	38.3	1.69	1.37	25.4	1.89	1.86	20.3	2.00	2.19	15.3	2.23	2.61	11.7	2.54	3.00								
65	66.6	1.52	0.96	41.4	1.69	1.38	27.5	1.89	1.86	22.0	2.01	2.19	16.6	2.24	2.60	12.7	2.55	2.98	10.6	2.88	3.16					
70	71.6	1.51	0.96	44.6	1.70	1.38	29.5	1.88	1.88	23.6	1.99	2.21	17.8	2.22	2.63	13.6	2.52	3.03	11.3	2.82	3.26					
75	76.6	1.51	0.96	47.7	1.69	1.38	31.6	1.88	1.88	25.3	2.00	2.21	19.0	2.21	2.66	14.5	2.50	3.08	12.0	2.77	3.35					
80	81.6	1.52	0.96	50.8	1.69	1.38	33.7	1.88	1.88	26.9	1.99	2.22	20.3	2.22	2.64	15.4	2.48	3.11	12.7	2.73	3.43					
90	91.7	1.52	0.96	57.1	1.69	1.39	37.8	1.88	1.89	30.2	1.98	2.24	22.8	2.21	2.65	17.3	2.47	3.13	14.2	2.69	3.49	11.8	2.99	3.78		
100	101.7	1.52	0.96	63.4	1.69	1.39	42.0	1.88	1.89	33.5	1.98	2.24	25.2	2.19	2.69	19.2	2.47	3.14	15.7	2.67	3.55	13.0	2.94	3.88		
110	111.7	1.52	0.97	69.6	1.69	1.39	46.1	1.87	1.90	36.8	1.98	2.25	27.7	2.19	2.70	21.0	2.44	3.20	17.3	2.68	3.53	14.3	2.94	3.88	12.4	3.23	4.07
120	121.7	1.52	0.97	75.8	1.69	1.39	50.2	1.87	1.90	40.1	1.98	2.26	30.2	2.19	2.70	22.9	2.44	3.20	18.8	2.66	3.57	15.5	2.91	3.96	13.4	3.17	4.19
130	131.6	1.51	0.97	82.1	1.69	1.39	54.4	1.87	1.90	43.4	1.97	2.26	32.7	2.19	2.70	24.8	2.44	3.20	20.3	2.64	3.61	16.7	2.88	4.03	14.4	3.12	4.30
140	141.5	1.51	0.97	88.3	1.69	1.39	58.5	1.87	1.90	46.7	1.97	2.26	35.2	2.19	2.70	26.6	2.42	3.24	21.8	2.63	3.64	17.9	2.85	4.08	15.5	3.12	4.31
150	151.4	1.52	0.97	94.5	1.69	1.40	62.6	1.87	1.91	50.0	1.98	2.26	37.6	2.18	2.72	28.5	2.42	3.23	23.3	2.62	3.66	19.2	2.86	4.07	16.5	3.08	4.39
160	161.3	1.52	0.97	100.7	1.69	1.40	66.7	1.87	1.91	53.3	1.98	2.26	40.1	2.18	2.72	30.4	2.43	3.23	24.8	2.61	3.68	20.4	2.84	4.11	17.6	3.08	4.39
170	171.1	1.52	0.97	106.8	1.69	1.40	70.8	1.87	1.91	56.5	1.97	2.28	42.6	2.19	2.72	32.2	2.41	3.26	26.3	2.60	3.70	21.7	2.85	4.10	18.6	3.05	4.46
180	180.9	1.52	0.98	113.0	1.69	1.40	74.9	1.87	1.91	59.8	1.97	2.27	45.0	2.18	2.73	34.1	2.42	3.25	27.9	2.61	3.68	22.9	2.83	4.14	19.6	3.02	4.52
190	190.6	1.52	0.98	119.1	1.69	1.40	79.0	1.87	1.91	63.1	1.98	2.27	47.5	2.18	2.73	35.9	2.41	3.27	29.4	2.61	3.69	24.1	2.81	4.17	20.7	3.03	4.51
200	200.4	1.52	0.98	125.3	1.69	1.40	83.0	1.87	1.92	66.3	1.97	2.28	49.9	2.18	2.74	37.8	2.41	3.27	30.9	2.60	3.71	25.4	2.82	4.15	21.7	3.00	4.57
220	220.1	1.52	0.98	137.6	1.69	1.41	91.2	1.87	1.92	72.9	1.97	2.28	54.9	2.18	2.74	41.5	2.41	3.28	33.9	2.59	3.73	27.9	2.82	4.17	23.8	2.99	4.61
240	239.8	1.52	0.98	150.0	1.69	1.41	99.4	1.87	1.93	79.5	1.98	2.28	59.8	2.18	2.75	45.3	2.41	3.28	37.0	2.60	3.72	30.4	2.81	4.18	25.9	2.97	4.64
260	259.4	1.52	0.98	162.3	1.69	1.41	107.6	1.87	1.93	86.0	1.97	2.28	64.8	2.18	2.74	49.0	2.41	3.29	40.0	2.59	3.75	32.9	2.81	4.20	28.0	2.96	4.67
280	279.0	1.52	0.98	174.6	1.70	1.41	115.8	1.87	1.93	92.5	1.97	2.29	69.7	2.18	2.75	52.7	2.40	3.30	43.0	2.58	3.76	35.3	2.79	4.24	30.2	2.97	4.65
300	298.5	1.52	0.98	186.9	1.70	1.41	123.9	1.87	1.93	99.1	1.98	2.29	74.6	2.18	2.75	56.4	2.40	3.30	46.1	2.59	3.75	37.8	2.79	4.24	32.3	2.97	4.67

Table 6-20.2 - Parabolic waterway design
(Retardance "D" and "B")

V_1 for RETARDANCE "D". Top Width (T), Depth (D) and V_2 for RETARDANCE "B".

Grade 2.0 Percent

Q cfs	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	24.7	1.14	0.79	15.0	1.25	1.18	11.0	1.40	1.43	7.8	1.56	1.81														
20	32.8	1.14	0.79	20.0	1.25	1.18	14.5	1.37	1	10.3	1.53	1.88	7.5	1.71	2.29	6.3	1.91	2.44								
25	41.0	1.14	0.79	24.9	1.24	1.20	18.1	1.37	1.50	12.7	1.48	1.96	9.3	1.68	2.36	7.7	1.82	2.62								
30	49.0	1.14	0.80	29.8	1.24	1.20	21.6	1.35	1.52	15.2	1.48	1.98	11.0	1.63	2.47	9.1	1.77	2.76	7.6	1.97	2.95					
35	57.1	1.14	0.80	34.7	1.24	1.21	25.1	1.35	1.54	17.7	1.47	1.99	12.8	1.62	2.50	10.5	1.73	2.86	8.8	1.94	3.03					
40	65.1	1.14	0.80	39.6	1.24	1.21	28.7	1.35	1.53	20.2	1.47	2.00	14.6	1.62	2.51	12.0	1.73	2.86	9.9	1.88	3.18	8.2	2.13	3.38		
45	73.1	1.14	0.80	44.5	1.24	1.21	32.2	1.35	1.54	22.6	1.46	2.03	16.4	1.61	2.52	13.5	1.73	2.86	11.1	1.87	3.21	9.1	2.08	3.52		
50	81.0	1.14	0.81	49.3	1.24	1.22	35.7	1.35	1.55	25.1	1.46	2.03	18.1	1.59	2.57	14.9	1.71	2.92	12.3	1.86	3.24	10.0	2.03	3.64	8.6	2.29	3.76
55	88.9	1.14	0.81	54.2	1.24	1.21	39.2	1.34	1.55	27.6	1.46	2.03	19.9	1.60	2.57	16.4	1.71	2.91	13.5	1.85	3.26	11.0	2.03	3.65	9.3	2.21	3.96
60	96.8	1.14	0.81	59.0	1.24	1.22	42.7	1.34	1.55	30.0	1.45	2.05	21.7	1.60	2.57	17.8	1.69	2.95	14.7	1.85	3.28	11.9	2.00	3.74	10.1	2.19	4.01
65	104.6	1.14	0.81	63.8	1.24	1.22	46.2	1.35	1.55	32.5	1.46	2.04	23.4	1.58	2.60	19.3	1.70	2.94	15.8	1.82	3.36	12.9	2.00	3.73	10.9	2.18	4.06
70	112.4	1.14	0.81	68.6	1.24	1.22	49.7	1.35	1.56	34.9	1.45	2.05	25.2	1.59	2.60	20.7	1.69	2.98	17.0	1.82	3.36	13.8	1.98	3.81	11.7	2.16	4.10
75	120.2	1.14	0.81	73.4	1.24	1.22	53.1	1.34	1.56	37.3	1.45	2.06	27.0	1.59	2.60	22.2	1.69	2.96	18.2	1.82	3.37	14.8	1.98	3.79	12.5	2.15	4.14
80	127.9	1.14	0.82	78.1	1.24	1.23	56.6	1.35	1.56	39.8	1.45	2.06	28.7	1.58	2.62	23.6	1.69	2.99	19.4	1.82	3.37	15.8	1.99	3.78	13.3	2.14	4.17
90	143.6	1.14	0.82	87.8	1.24	1.23	63.5	1.34	1.57	44.7	1.45	2.06	32.3	1.59	2.61	26.5	1.68	3.00	21.8	1.82	3.38	17.7	1.97	3.83	14.9	2.12	4.22
100	159.2	1.14	0.82	97.4	1.24	1.23	70.5	1.34	1.57	49.6	1.45	2.07	35.8	1.58	2.63	29.4	1.68	3.01	24.1	1.80	3.43	19.6	1.96	3.87	16.5	2.11	4.26
110	174.8	1.14	0.82	106.9	1.24	1.23	77.4	1.34	1.57	54.5	1.45	2.07	39.3	1.58	2.64	32.3	1.68	3.02	26.5	1.80	3.43	21.5	1.95	3.90	18.1	2.10	4.30
120	190.3	1.14	0.82	116.5	1.24	1.23	84.3	1.34	1.58	59.4	1.45	2.07	42.8	1.58	2.65	35.2	1.68	3.02	28.9	1.80	3.43	23.4	1.94	3.92	19.7	2.09	4.33
130	205.7	1.14	0.82	126.0	1.24	1.23	91.2	1.34	1.58	64.2	1.45	2.08	46.4	1.58	2.64	38.1	1.68	3.03	31.3	1.80	3.43	25.4	1.95	3.90	21.3	2.09	4.35
140	221.0	1.14	0.82	135.4	1.24	1.24	98.0	1.34	1.58	69.1	1.45	2.08	49.9	1.58	2.64	41.0	1.68	3.03	33.6	1.80	3.46	27.3	1.95	3.92	22.9	2.08	4.37
150	236.3	1.14	0.83	144.9	1.25	1.24	104.9	1.34	1.58	73.9	1.45	2.08	53.4	1.58	2.65	43.9	1.68	3.03	36.0	1.80	3.45	29.2	1.95	3.93	24.5	2.08	4.38
160	251.5	1.14	0.83	154.3	1.25	1.24	111.7	1.34	1.59	78.7	1.45	2.09	56.9	1.58	2.65	46.7	1.67	3.05	38.3	1.79	3.47	31.1	1.94	3.94	26.1	2.08	4.40
170	266.6	1.14	0.83	163.7	1.25	1.24	118.5	1.34	1.59	83.6	1.45	2.08	60.3	1.58	2.66	49.6	1.68	3.05	40.7	1.80	3.46	33.0	1.94	3.95	27.7	2.07	4.41
180	281.7	1.14	0.83	173.0	1.25	1.24	125.2	1.34	1.59	88.4	1.45	2.09	63.8	1.58	2.66	52.5	1.68	3.04	43.0	1.79	3.48	34.9	1.94	3.96	29.3	2.07	4.41
190	296.7	1.14	0.83	182.3	1.25	1.24	132.0	1.34	1.59	93.2	1.45	2.09	67.3	1.58	2.66	55.3	1.68	3.06	45.4	1.80	3.47	36.8	1.94	3.97	30.8	2.06	4.46
200	311.7	1.14	0.83	191.6	1.25	1.24	138.7	1.34	1.60	97.9	1.45	2.10	70.7	1.58	2.67	58.2	1.68	3.05	47.7	1.79	3.49	38.7	1.94	3.97	32.4	2.06	4.47
220	342.1	1.14	0.83	210.4	1.25	1.25	152.4	1.35	1.60	107.6	1.45	2.10	77.7	1.58	2.67	63.9	1.68	3.06	52.5	1.80	3.47	42.5	1.93	3.99	35.6	2.06	4.48
240	372.4	1.14	0.84	229.2	1.25	1.25	165.9	1.34	1.60	117.2	1.45	2.10	84.7	1.58	2.67	69.7	1.68	3.06	57.2	1.80	3.48	46.4	1.94	3.97	38.8	2.06	4.49
260	402.5	1.14	0.84	247.9	1.25	1.25	179.5	1.34	1.60	126.8	1.45	2.10	91.7	1.58	2.67	75.4	1.68	3.07	61.9	1.80	3.49	50.2	1.94	3.99	42.0	2.06	4.49
280	432.6	1.14	0.84	266.5	1.25	1.25	193.0	1.34	1.61	136.4	1.45	2.10	98.6	1.58	2.68	81.1	1.68	3.07	66.6	1.80	3.49	54.0	1.94	3.99	45.2	2.06	4.49
300	462.5	1.14	0.84	285.1	1.25	1.25	206.5	1.35	1.61	146.0	1.46	2.10	105.5	1.58	2.69	86.8	1.68	3.07	71.2	1.79	3.51	57.8	1.94	4.00	48.4	2.06	4.50

Table 6-20.2 - Parabolic waterway design
(Retardance "D" and "B")

V_1 for RETARDANCE "D". Top Width (T), Depth (D) and V_2 for RETARDANCE "B".

Grade 4.0 Percent

Q cfs	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	33.1	0.87	0.77	23.6	0.93	1.01	16.3	1.00	1.36	12.1	1.08	1.69	9.2	1.15	2.08	7.4	1.27	2.34	5.7	1.43	2.69						
20	44.0	0.87	0.77	31.4	0.93	1.01	21.7	1.00	1.37	16.1	1.08	1.70	12.3	1.16	2.08	9.7	1.23	2.48	7.4	1.35	2.94	6.4	1.47	3.12			
25	54.9	0.87	0.77	39.1	0.93	1.02	27.1	1.00	1.37	20.1	1.08	1.71	15.3	1.15	2.11	12.1	1.22	2.50	9.2	1.33	3.01	7.9	1.43	3.26	6.5	1.56	3.62
30	65.7	0.87	0.78	46.8	0.93	1.02	32.4	0.99	1.38	24.0	1.07	1.73	18.3	1.14	2.13	14.4	1.20	2.57	11.0	1.32	3.05	9.3	1.38	3.46	7.7	1.52	3.78
35	76.4	0.87	0.78	54.5	0.93	1.02	37.7	0.99	1.39	27.9	1.07	1.74	21.3	1.14	2.14	16.8	1.20	2.57	12.7	1.30	3.14	10.9	1.39	3.42	8.9	1.49	3.90
40	87.1	0.87	0.78	62.1	0.93	1.03	43.0	0.99	1.39	31.9	1.07	1.74	24.3	1.14	2.15	19.2	1.21	2.56	14.5	1.30	3.15	12.4	1.38	3.47	10.2	1.50	3.87
45	97.7	0.87	0.78	69.7	0.93	1.03	48.3	0.99	1.39	35.8	1.07	1.74	27.2	1.13	2.17	21.5	1.20	2.59	16.3	1.30	3.16	13.9	1.37	3.51	11.4	1.48	3.95
50	108.3	0.87	0.78	77.3	0.93	1.03	53.5	0.99	1.40	39.7	1.07	1.75	30.2	1.13	2.17	23.9	1.20	2.58	18.1	1.30	3.16	15.4	1.36	3.54	12.6	1.46	4.01
55	118.8	0.87	0.78	84.7	0.93	1.04	58.7	0.99	1.40	43.6	1.07	1.75	33.2	1.13	2.17	26.2	1.20	2.60	19.8	1.29	3.21	16.9	1.36	3.56	13.8	1.45	4.06
60	129.2	0.87	0.79	92.2	0.93	1.04	63.9	0.99	1.40	47.4	1.07	1.76	36.1	1.13	2.18	28.5	1.19	2.62	21.6	1.29	3.20	18.4	1.36	3.57	15.1	1.46	4.02
65	139.6	0.87	0.79	99.6	0.93	1.04	69.1	0.99	1.41	51.3	1.07	1.76	39.0	1.13	2.19	30.9	1.20	2.61	23.4	1.29	3.19	19.9	1.35	3.58	16.3	1.46	4.06
70	149.9	0.88	0.79	107.0	0.93	1.04	74.2	0.99	1.41	55.1	1.07	1.77	42.0	1.13	2.19	33.2	1.20	2.62	25.1	1.28	3.23	21.4	1.35	3.59	17.5	1.45	4.09
75	160.2	0.88	0.79	114.3	0.93	1.05	79.3	0.99	1.42	58.9	1.07	1.77	44.9	1.13	2.19	35.5	1.20	2.62	26.9	1.29	3.22	22.9	1.35	3.60	18.7	1.45	4.12
80	170.4	0.88	0.79	121.6	0.93	1.05	84.4	0.99	1.42	62.7	1.07	1.77	47.8	1.13	2.20	37.8	1.20	2.63	28.6	1.28	3.24	24.4	1.35	3.60	20.0	1.46	4.08
90	191.1	0.88	0.80	136.5	0.93	1.05	94.8	0.99	1.42	70.4	1.07	1.78	53.7	1.13	2.20	42.4	1.19	2.65	32.1	1.28	3.26	27.4	1.35	3.62	22.4	1.45	4.13
100	211.8	0.88	0.80	151.2	0.93	1.05	105.1	0.99	1.42	78.1	1.07	1.78	59.6	1.13	2.20	47.1	1.20	2.64	35.7	1.29	3.24	30.4	1.35	3.63	24.9	1.45	4.12
110	232.3	0.88	0.80	165.9	0.93	1.06	115.3	0.99	1.43	85.8	1.07	1.78	65.4	1.13	2.21	51.7	1.19	2.65	39.2	1.29	3.25	33.4	1.35	3.63	27.3	1.44	4.16
120	252.7	0.88	0.80	180.5	0.93	1.06	125.5	0.99	1.43	93.4	1.07	1.78	71.2	1.13	2.22	56.3	1.19	2.66	42.7	1.28	3.26	36.3	1.34	3.66	29.8	1.45	4.14
130	273.0	0.88	0.80	195.1	0.93	1.06	135.6	0.99	1.43	101.0	1.07	1.79	77.0	1.13	2.22	60.9	1.19	2.66	46.2	1.29	3.26	39.3	1.34	3.66	32.2	1.44	4.16
140	293.2	0.88	0.80	209.5	0.93	1.06	145.7	0.99	1.44	108.5	1.07	1.79	82.8	1.13	2.22	65.5	1.20	2.66	49.6	1.28	3.28	42.3	1.35	3.66	34.6	1.44	4.18
150	313.3	0.88	0.81	223.9	0.93	1.07	155.8	0.99	1.44	116.0	1.07	1.80	88.6	1.13	2.22	70.1	1.20	2.66	53.1	1.28	3.28	45.3	1.35	3.66	37.1	1.45	4.17
160	333.2	0.88	0.81	238.2	0.93	1.07	165.8	1.00	1.44	123.5	1.07	1.80	94.3	1.13	2.23	74.6	1.20	2.67	56.6	1.28	3.28	48.2	1.35	3.67	39.5	1.44	4.18
170	353.1	0.88	0.81	252.4	0.93	1.07	175.8	1.00	1.44	131.0	1.07	1.80	100.0	1.13	2.23	79.2	1.20	2.67	60.0	1.28	3.29	51.2	1.35	3.67	41.9	1.44	4.19
180	372.8	0.88	0.81	266.5	0.93	1.07	185.7	1.00	1.45	138.4	1.07	1.80	105.7	1.13	2.24	83.7	1.20	2.68	63.5	1.28	3.29	54.1	1.35	3.68	44.3	1.44	4.20
190	392.4	0.88	0.81	280.6	0.93	1.08	195.6	1.00	1.45	145.8	1.07	1.81	111.4	1.13	2.24	88.2	1.20	2.68	66.9	1.28	3.30	57.0	1.34	3.69	46.7	1.44	4.21
200	411.9	0.88	0.82	294.6	0.93	1.08	205.4	1.00	1.45	153.2	1.07	1.81	117.1	1.14	2.24	92.7	1.20	2.68	70.3	1.28	3.30	60.0	1.35	3.68	49.1	1.44	4.21
220	451.9	0.88	0.82	323.2	0.93	1.08	225.4	1.00	1.46	168.2	1.07	1.81	128.6	1.14	2.24	101.9	1.20	2.68	77.2	1.28	3.31	65.9	1.35	3.69	54.0	1.44	4.21
240	491.6	0.88	0.82	351.6	0.93	1.09	245.3	1.00	1.46	183.2	1.07	1.81	140.0	1.14	2.25	110.9	1.20	2.69	84.1	1.28	3.32	71.8	1.35	3.70	58.8	1.44	4.22
260	531.0	0.88	0.82	379.9	0.93	1.09	265.2	1.00	1.46	198.0	1.07	1.82	151.5	1.14	2.25	120.0	1.20	2.69	91.0	1.28	3.32	77.7	1.35	3.70	63.7	1.44	4.21
280	570.3	0.88	0.82	408.0	0.93	1.09	284.9	1.00	1.47	212.9	1.08	1.82	162.8	1.14	2.25	129.0	1.20	2.70	97.9	1.28	3.32	83.5	1.35	3.71	68.5	1.44	4.22
300	609.3	0.88	0.83	436.0	0.93	1.09	304.6	1.00	1.47	227.6	1.08	1.83	174.2	1.14	2.25	138.1	1.20	2.69	104.8	1.29	3.32	89.4	1.35	3.71	73.3	1.44	4.23

Table 6-20.2 - Parabolic waterway design
(Retardance "D" and "B")

V_1 for RETARDANCE "D". Top Width (T), Depth (D) and V_2 for RETARDANCE "B".

Grade 6.0 Percent

Q cfs	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	40.5	0.72	0.76	26.9	0.81	1.02	19.6	0.85	1.34	14.8	0.90	1.66	11.7	0.96	1.97	9.4	1.02	2.31	7.6	1.09	2.67	6.1	1.18	3.05	5.0	1.32	3.33
20	53.9	0.72	0.76	35.7	0.81	1.03	26.1	0.85	1.34	19.6	0.89	1.69	15.6	0.96	1.97	12.5	1.01	2.33	10.1	1.08	2.71	8.0	1.14	3.23	6.5	1.24	3.63
25	67.1	0.72	0.76	44.5	0.81	1.03	32.5	0.85	1.35	24.5	0.90	1.69	19.4	0.95	2.00	15.5	1.00	2.39	12.5	1.06	2.80	10.0	1.14	3.24	8.1	1.23	3.69
30	80.3	0.72	0.76	53.2	0.80	1.04	38.9	0.85	1.35	29.3	0.89	1.70	23.3	0.96	1.99	18.6	1.00	2.39	15.0	1.06	2.80	11.9	1.12	3.32	9.6	1.20	3.84
35	93.4	0.72	0.76	61.9	0.81	1.04	45.3	0.85	1.35	34.1	0.89	1.70	27.1	0.96	2.00	21.6	0.99	2.42	17.4	1.05	2.84	13.9	1.13	3.31	11.2	1.20	3.84
40	106.4	0.73	0.77	70.6	0.81	1.04	51.6	0.85	1.36	38.9	0.89	1.71	30.9	0.95	2.01	24.7	1.00	2.41	19.9	1.05	2.83	15.8	1.12	3.36	12.7	1.19	3.93
45	119.3	0.73	0.77	79.2	0.81	1.04	57.9	0.85	1.36	43.7	0.90	1.71	34.6	0.95	2.03	27.7	1.00	2.42	22.3	1.05	2.86	17.7	1.11	3.40	14.3	1.19	3.92
50	132.1	0.73	0.77	87.7	0.81	1.05	64.1	0.84	1.37	48.4	0.89	1.71	38.4	0.95	2.03	30.7	0.99	2.43	24.7	1.05	2.87	19.7	1.12	3.38	15.8	1.18	3.98
55	144.9	0.73	0.77	96.2	0.81	1.05	70.4	0.85	1.37	53.1	0.89	1.72	42.2	0.95	2.03	33.7	0.99	2.44	27.1	1.04	2.89	21.6	1.11	3.40	17.4	1.18	3.96
60	157.5	0.73	0.77	104.6	0.81	1.05	76.5	0.84	1.38	57.8	0.89	1.72	45.9	0.95	2.04	36.7	1.00	2.44	29.6	1.05	2.87	23.5	1.11	3.42	18.9	1.18	4.01
65	170.1	0.73	0.78	113.0	0.81	1.06	82.7	0.85	1.38	62.5	0.90	1.72	49.6	0.95	2.04	39.7	1.00	2.44	32.0	1.05	2.88	25.4	1.11	3.43	20.5	1.18	3.98
70	182.6	0.73	0.78	121.3	0.81	1.06	88.8	0.85	1.38	67.2	0.90	1.72	53.3	0.95	2.05	42.7	1.00	2.44	34.4	1.05	2.88	27.4	1.11	3.41	22.0	1.18	4.01
75	195.1	0.73	0.78	129.6	0.81	1.06	94.9	0.85	1.39	71.8	0.90	1.73	57.0	0.95	2.05	45.6	1.00	2.46	36.7	1.04	2.91	29.3	1.11	3.42	23.6	1.18	3.99
80	207.4	0.73	0.78	137.8	0.81	1.06	100.9	0.85	1.39	76.4	0.90	1.73	60.6	0.95	2.06	48.6	1.00	2.45	39.1	1.05	2.91	31.2	1.11	3.42	25.1	1.18	4.02
90	232.6	0.73	0.78	154.5	1.81	1.07	113.2	0.85	1.40	85.8	0.90	1.73	68.1	0.95	2.06	54.6	1.00	2.45	43.9	1.05	2.92	35.0	1.11	3.44	28.2	1.18	4.02
100	257.7	0.73	0.78	171.2	0.81	1.07	125.5	0.85	1.40	95.1	0.90	1.74	75.5	0.95	2.06	60.5	1.00	2.46	48.7	1.05	2.92	38.8	1.11	3.46	31.3	1.18	4.03
110	282.6	0.74	0.78	187.8	0.81	1.07	137.7	0.85	1.40	104.4	0.90	1.74	82.8	0.95	2.07	66.4	1.00	2.47	53.5	1.05	2.92	42.6	1.11	3.47	34.4	1.18	4.03
120	307.3	0.74	0.79	204.2	0.81	1.08	149.8	0.85	1.40	113.6	0.90	1.74	90.2	0.95	2.07	72.3	1.00	2.47	58.3	1.05	2.92	46.4	1.11	3.47	37.4	1.18	4.06
130	331.9	0.74	0.79	220.6	0.81	1.08	161.9	0.85	1.41	122.8	0.90	1.75	97.5	0.95	2.08	78.2	1.00	2.48	63.0	1.05	2.93	50.2	1.11	3.48	40.5	1.18	4.05
140	356.3	0.74	0.79	236.8	0.81	1.08	173.9	0.85	1.41	131.9	0.90	1.75	104.7	0.95	2.09	84.0	1.00	2.48	67.7	1.05	2.94	54.0	1.11	3.48	43.5	1.18	4.07
150	380.5	0.74	0.79	253.0	0.81	1.09	185.8	0.85	1.41	141.0	0.90	1.75	112.0	0.96	2.09	89.9	1.00	2.48	72.5	1.05	2.93	57.8	1.11	3.48	46.6	1.18	4.06
160	404.6	0.74	0.79	269.0	0.81	1.09	197.7	0.85	1.42	150.1	0.90	1.76	119.2	0.96	2.09	95.7	1.00	2.49	77.2	1.05	2.94	61.5	1.11	3.49	49.6	1.18	4.08
170	428.6	0.74	0.79	285.0	0.81	1.09	209.5	0.85	1.42	159.1	0.90	1.76	126.4	0.96	2.09	101.5	1.00	2.49	81.8	1.05	2.95	65.3	1.11	3.49	52.7	1.18	4.07
180	452.4	0.74	0.79	300.8	0.81	1.09	221.3	0.85	1.42	168.1	0.90	1.76	133.5	0.96	2.10	107.2	1.00	2.50	86.5	1.05	2.95	69.0	1.11	3.49	55.7	1.18	4.08
190	476.1	0.74	0.80	316.6	0.81	1.10	233.0	0.85	1.42	177.0	0.90	1.77	140.6	0.96	2.10	113.0	1.00	2.50	91.1	1.05	2.96	72.7	1.11	3.50	58.7	1.18	4.08
200	499.6	0.74	0.80	332.3	0.81	1.10	244.6	0.85	1.43	185.9	0.90	1.77	147.7	0.96	2.11	118.7	1.00	2.50	95.8	1.05	2.96	76.4	1.11	3.51	61.7	1.18	4.09
220	547.7	0.74	0.80	364.5	0.81	1.10	268.4	0.85	1.43	204.1	0.91	1.77	162.1	0.96	2.11	130.3	1.00	2.51	105.2	1.05	2.96	83.9	1.11	3.51	67.8	1.18	4.09
240	595.6	0.74	0.80	396.5	0.81	1.11	292.1	0.85	1.43	222.1	0.91	1.78	176.5	0.96	2.11	141.9	1.00	2.51	114.5	1.05	2.97	91.4	1.11	3.52	73.8	1.18	4.11
260	643.2	0.74	0.80	428.3	0.81	1.11	315.7	0.85	1.43	240.1	0.91	1.78	190.7	0.96	2.12	153.4	1.00	2.52	123.9	1.05	2.97	98.9	1.11	3.52	79.9	1.18	4.10
280	690.5	0.75	0.81	459.9	0.81	1.11	339.1	0.85	1.44	258.0	0.91	1.78	205.0	0.96	2.12	164.9	1.00	2.52	133.2	1.05	2.97	106.3	1.11	3.53	85.9	1.18	4.11
300	737.5	0.75	0.81	491.4	0.81	1.11	362.4	0.85	1.44	275.8	0.91	1.78	219.1	0.96	2.13	176.3	1.00	2.52	142.4	1.05	2.98	113.7	1.11	3.53	91.9	1.18	4.12

Table 6-20.2 - Parabolic waterway design
(Retardance "D" and "B")

V_1 for RETARDANCE "D". Top Width (T), Depth (D) and V_2 for RETARDANCE "B".

Grade 8.0 Percent

Q cfs	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	43.1	0.64	0.80	31.6	0.71	0.98	22.2	0.76	1.31	18.0	0.79	1.56	13.7	0.84	1.92	11.0	0.89	2.26	9.2	0.95	2.54	7.4	0.99	3.00	6.2	1.09	3.26
20	57.3	0.64	0.80	42.0	0.71	0.99	29.5	0.76	1.32	24.0	0.79	1.56	18.2	0.84	1.94	14.7	0.89	2.25	12.2	0.93	2.59	9.8	0.98	3.08	8.1	1.04	3.49
25	71.4	0.65	0.80	52.3	0.71	0.99	36.7	0.76	1.33	29.9	0.79	1.57	22.7	0.84	1.95	18.3	0.89	2.28	15.2	0.93	2.62	12.2	0.97	3.12	10.1	1.04	3.53
30	85.4	0.65	0.80	62.6	0.71	0.99	43.9	0.76	1.33	35.8	0.79	1.57	27.2	0.84	1.95	21.9	0.89	2.29	18.1	0.92	2.67	14.6	0.97	3.15	12.1	1.03	3.55
35	99.3	0.65	0.80	72.8	0.72	0.99	51.1	0.76	1.34	41.6	0.79	1.58	31.7	0.84	1.95	25.5	0.89	2.30	21.1	0.92	2.67	17.0	0.96	3.16	14.0	1.02	3.64
40	113.1	0.65	0.81	82.9	0.72	1.00	58.2	0.76	1.34	47.4	0.79	1.59	36.1	0.84	1.96	29.0	0.88	2.32	24.1	0.92	2.67	19.4	0.96	3.17	16.0	1.02	3.63
45	126.8	0.65	0.81	93.0	0.72	1.00	65.3	0.76	1.34	53.2	0.79	1.59	40.5	0.84	1.97	32.6	0.88	2.32	27.0	0.92	2.69	21.8	0.97	3.17	18.0	1.02	3.62
50	140.4	0.65	0.81	102.9	0.72	1.01	72.3	0.76	1.35	59.0	0.79	1.59	44.9	0.84	1.97	36.1	0.88	2.33	30.0	0.92	2.68	24.2	0.97	3.17	19.9	1.02	3.67
55	153.9	0.65	0.81	112.8	0.72	1.01	79.3	0.76	1.35	64.7	0.79	1.60	49.3	0.84	1.97	39.6	0.88	2.34	32.9	0.92	2.70	26.5	0.96	3.20	21.9	1.02	3.65
60	167.3	0.65	0.81	122.7	0.72	1.01	86.2	0.76	1.36	70.4	0.79	1.60	53.7	0.84	1.97	43.1	0.88	2.34	35.8	0.92	2.70	28.9	0.97	3.19	23.8	1.02	3.69
65	180.6	0.65	0.82	132.4	0.72	1.01	93.1	0.76	1.36	76.0	0.79	1.61	58.0	0.84	1.98	46.6	0.88	2.35	38.7	0.92	2.71	31.3	0.97	3.18	25.7	1.01	3.71
70	193.9	0.65	0.82	142.2	0.72	1.01	100.0	0.76	1.37	81.7	0.79	1.61	62.3	0.84	1.98	50.1	0.88	2.35	41.6	0.92	2.71	33.6	0.97	3.20	27.7	1.02	3.69
75	207.0	0.65	0.82	151.8	0.72	1.02	106.8	0.76	1.37	87.2	0.79	1.62	66.6	0.84	1.99	53.5	0.88	2.36	44.5	0.92	2.72	35.9	0.96	3.22	29.6	1.02	3.71
80	220.1	0.66	0.82	161.4	0.72	1.02	113.6	0.76	1.37	92.8	0.79	1.62	70.9	0.84	1.99	56.9	0.88	2.37	47.3	0.92	2.73	38.2	0.96	3.23	31.5	1.01	3.72
90	246.8	0.66	0.82	180.9	0.72	1.02	127.4	0.76	1.38	104.1	0.79	1.62	79.5	0.84	2.00	63.9	0.88	2.37	53.1	0.92	2.74	42.9	0.96	3.23	35.4	1.02	3.72
100	273.3	0.66	0.82	200.3	0.72	1.03	141.1	0.76	1.38	115.4	0.79	1.62	88.1	0.84	2.00	70.8	0.88	2.38	58.9	0.92	2.74	47.6	0.97	3.24	39.2	1.01	3.75
110	299.6	0.66	0.83	219.6	0.72	1.03	154.8	0.76	1.38	126.5	0.79	1.63	96.7	0.84	2.01	77.7	0.88	2.38	64.7	0.92	2.74	52.3	0.97	3.23	43.1	1.02	3.74
120	325.7	0.66	0.83	238.8	0.72	1.03	168.4	0.76	1.39	137.7	0.79	1.63	105.3	0.84	2.01	84.6	0.88	2.39	70.4	0.92	2.75	56.9	0.97	3.25	46.9	1.01	3.75
130	351.7	0.66	0.83	257.9	0.72	1.04	181.9	0.76	1.39	148.7	0.79	1.64	113.8	0.84	2.01	91.4	0.88	2.40	76.1	0.92	2.75	61.6	0.97	3.24	50.7	1.01	3.76
140	377.5	0.66	0.83	276.8	0.72	1.04	195.3	0.76	1.39	159.7	0.79	1.64	122.2	0.84	2.02	98.2	0.88	2.40	81.8	0.92	2.76	66.2	0.97	3.25	54.5	1.01	3.77
150	403.1	0.66	0.83	295.6	0.72	1.04	208.6	0.76	1.40	170.7	0.80	1.64	130.6	0.84	2.02	105.0	0.88	2.40	87.4	0.92	2.77	70.8	0.97	3.25	58.3	1.01	3.78
160	428.5	0.66	0.83	314.2	0.72	1.04	221.9	0.76	1.40	181.5	0.79	1.65	139.0	0.85	2.02	111.7	0.88	2.41	93.1	0.92	2.77	75.3	0.97	3.27	62.1	1.01	3.78
170	453.8	0.66	0.84	332.8	0.72	1.05	235.1	0.76	1.40	192.4	0.80	1.65	147.3	0.85	2.03	118.4	0.88	2.42	98.7	0.92	2.77	79.9	0.97	3.27	65.9	1.02	3.78
180	478.9	0.66	0.84	351.2	0.72	1.05	248.2	0.76	1.41	203.1	0.80	1.65	155.6	0.85	2.03	125.1	0.88	2.42	104.3	0.93	2.78	84.4	0.97	3.28	69.6	1.02	3.79
190	503.9	0.66	0.84	369.5	0.72	1.05	261.2	0.77	1.41	213.8	0.80	1.66	163.9	0.85	2.03	131.8	0.89	2.42	109.8	0.92	2.79	89.0	0.97	3.27	73.4	1.02	3.79
200	528.5	0.67	0.84	387.7	0.73	1.05	274.1	0.77	1.42	224.4	0.80	1.66	172.1	0.85	2.04	138.4	0.89	2.43	115.3	0.92	2.79	93.5	0.97	3.28	77.1	1.02	3.80
220	579.5	0.67	0.84	425.1	0.73	1.06	300.7	0.77	1.42	246.2	0.80	1.66	188.8	0.85	2.04	151.8	0.88	2.44	126.6	0.93	2.80	102.6	0.97	3.29	84.7	1.02	3.80
240	630.1	0.67	0.84	462.2	0.73	1.06	327.0	0.77	1.42	267.9	0.80	1.67	205.5	0.85	2.05	165.2	0.89	2.44	137.8	0.93	2.80	111.8	0.97	3.29	92.2	1.02	3.81
260	680.4	0.67	0.85	499.1	0.73	1.06	353.3	0.77	1.42	289.4	0.80	1.67	222.1	0.85	2.05	178.6	0.89	2.45	149.0	0.93	2.80	120.8	0.97	3.30	99.7	1.02	3.82
280	730.4	0.67	0.85	535.6	0.73	1.07	379.3	0.77	1.43	310.8	0.80	1.68	238.6	0.85	2.05	191.9	0.89	2.45	160.1	0.93	2.81	129.9	0.97	3.30	107.2	1.02	3.82
300	780.0	0.67	0.85	572.1	0.73	1.07	405.2	0.77	1.43	332.1	0.80	1.68	255.0	0.85	2.06	205.1	0.89	2.46	171.2	0.93	2.81	138.9	0.97	3.31	114.7	1.02	3.82

Table 6-20.2 - Parabolic waterway design
(Retardance "D" and "B")

V_1 for RETARDANCE "D". Top Width (T), Depth (D) and V_2 for RETARDANCE "B".

Grade 10.0 Percent

Q cfs	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	51.4	0.56	0.77	38.3	0.63	0.92	27.2	0.69	1.18	19.6	0.73	1.56	15.7	0.76	1.86	12.6	0.81	2.18	10.6	0.85	2.45	8.7	0.90	2.83	7.2	0.94	3.26
20	68.2	0.55	0.78	50.9	0.63	0.92	36.2	0.69	1.18	26.1	0.73	1.56	20.9	0.76	1.87	16.8	0.81	2.18	14.0	0.84	2.53	11.5	0.88	2.91	9.5	0.92	3.39
25	85.0	0.56	0.78	63.4	0.63	0.92	45.1	0.69	1.19	32.5	0.73	1.57	26.1	0.76	1.87	20.9	0.80	2.20	17.5	0.84	2.52	14.3	0.87	2.96	11.9	0.92	3.37
30	101.6	0.56	0.78	75.8	0.63	0.92	53.9	0.69	1.20	38.8	0.72	1.58	31.2	0.76	1.88	25.0	0.80	2.22	20.9	0.83	2.55	17.1	0.87	2.98	14.2	0.91	3.42
35	118.1	0.56	0.78	88.1	0.63	0.93	62.7	0.69	1.20	45.2	0.73	1.58	36.3	0.76	1.88	29.1	0.80	2.22	24.3	0.83	2.57	19.9	0.87	3.00	16.5	0.91	3.46
40	134.4	0.56	0.79	100.3	0.64	0.93	71.3	0.69	1.21	51.5	0.73	1.59	41.3	0.76	1.90	33.2	0.80	2.22	27.7	0.83	2.58	22.7	0.87	3.00	18.9	0.91	3.43
45	150.7	0.56	0.79	112.5	0.64	0.93	80.0	0.69	1.21	57.7	0.72	1.60	46.4	0.76	1.90	37.2	0.80	2.24	31.1	0.83	2.58	25.5	0.87	3.01	21.2	0.91	3.45
50	166.8	0.56	0.79	124.5	0.64	0.93	88.5	0.69	1.21	63.9	0.72	1.60	51.3	0.76	1.91	41.3	0.80	2.23	34.5	0.83	2.58	28.3	0.87	3.01	23.5	0.91	3.46
55	182.8	0.56	0.79	136.4	0.64	0.93	97.1	0.69	1.21	70.1	0.73	1.60	56.3	0.76	1.92	45.3	0.80	2.24	37.8	0.83	2.60	31.1	0.87	3.00	25.8	0.91	3.47
60	198.6	0.56	0.79	148.2	0.64	0.94	105.5	0.69	1.22	76.2	0.72	1.61	61.2	0.76	1.92	49.3	0.80	2.25	41.1	0.83	2.61	33.8	0.87	3.02	28.1	0.91	3.47
65	214.3	0.57	0.79	160.0	0.64	0.94	113.9	0.69	1.22	82.3	0.73	1.62	66.2	0.76	1.92	53.2	0.80	2.26	44.4	0.83	2.62	36.5	0.87	3.04	30.3	0.91	3.51
70	229.9	0.57	0.79	171.6	0.64	0.94	122.2	0.69	1.23	88.4	0.73	1.62	71.0	0.76	1.93	57.2	0.80	2.26	47.7	0.83	2.63	39.3	0.87	3.03	32.6	0.91	3.50
75	245.4	0.57	0.80	183.2	0.64	0.94	130.5	0.69	1.23	94.4	0.73	1.62	75.9	0.76	1.94	61.1	0.80	2.27	51.0	0.83	2.63	42.0	0.87	3.04	34.9	0.91	3.50
80	260.7	0.57	0.80	194.6	0.64	0.95	138.6	0.69	1.24	100.3	0.73	1.63	80.7	0.76	1.94	65.0	0.80	2.27	54.3	0.83	2.63	44.7	0.87	3.04	37.1	0.91	3.52
90	292.1	0.57	0.80	218.1	0.64	0.95	155.4	0.69	1.24	112.5	0.73	1.64	90.5	0.76	1.95	73.0	0.81	2.27	60.9	0.83	2.64	50.1	0.87	3.06	41.7	0.91	3.52
100	323.3	0.57	0.80	241.5	0.64	0.95	172.1	0.69	1.24	124.6	0.73	1.64	100.3	0.76	1.95	80.9	0.81	2.28	67.5	0.83	2.65	55.6	0.87	3.06	46.2	0.91	3.53
110	354.3	0.57	0.80	264.6	0.64	0.96	188.6	0.69	1.25	136.7	0.73	1.64	110.0	0.76	1.96	88.7	0.81	2.29	74.1	0.83	2.65	61.0	0.87	3.07	50.7	0.91	3.54
120	385.0	0.57	0.80	287.6	0.64	0.96	205.0	0.69	1.25	148.7	0.73	1.65	119.6	0.76	1.97	96.5	0.81	2.29	80.6	0.83	2.66	66.4	0.87	3.08	55.2	0.91	3.55
130	415.5	0.57	0.81	310.3	0.65	0.96	221.3	0.69	1.26	160.6	0.73	1.65	129.3	0.76	1.97	104.3	0.81	2.30	87.1	0.83	2.67	71.8	0.87	3.08	59.7	0.91	3.55
140	445.7	0.57	0.81	333.0	0.65	0.96	237.5	0.69	1.26	172.5	0.73	1.65	138.8	0.76	1.97	112.1	0.81	2.30	93.5	0.83	2.68	77.1	0.87	3.09	64.2	0.91	3.55
150	475.7	0.58	0.81	355.4	0.65	0.97	253.6	0.69	1.26	184.2	0.73	1.66	148.4	0.76	1.97	119.8	0.81	2.30	100.0	0.83	2.68	82.5	0.88	3.09	68.6	0.91	3.57
160	505.5	0.58	0.81	377.7	0.65	0.97	269.5	0.69	1.27	195.9	0.73	1.66	157.8	0.76	1.98	127.4	0.81	2.31	106.4	0.83	2.69	87.8	0.88	3.10	73.0	0.91	3.58
170	535.0	0.58	0.81	399.7	0.65	0.97	285.3	0.69	1.27	207.6	0.73	1.66	167.2	0.76	1.98	135.0	0.81	2.32	112.8	0.83	2.69	93.0	0.87	3.11	77.5	0.91	3.57
180	564.3	0.58	0.81	421.7	0.65	0.97	301.0	0.70	1.28	219.1	0.73	1.67	176.6	0.76	1.99	142.6	0.81	2.32	119.1	0.83	2.70	98.3	0.88	3.11	81.8	0.91	3.59
190	593.4	0.58	0.82	443.4	0.65	0.98	316.6	0.70	1.28	230.6	0.73	1.67	185.9	0.76	1.99	150.1	0.81	2.33	125.4	0.83	2.71	103.5	0.88	3.12	86.2	0.91	3.59
200	622.2	0.58	0.82	465.0	0.65	0.98	332.1	0.70	1.28	242.1	0.73	1.68	195.2	0.76	1.99	157.6	0.81	2.33	131.7	0.83	2.71	108.7	0.88	3.13	90.6	0.92	3.59
220	681.9	0.58	0.82	509.6	0.65	0.98	364.1	0.70	1.29	265.5	0.73	1.68	214.1	0.76	2.00	173.0	0.81	2.33	144.6	0.83	2.71	119.3	0.88	3.13	99.4	0.91	3.60
240	741.1	0.58	0.82	553.8	0.65	0.99	395.9	0.70	1.29	288.8	0.73	1.68	233.0	0.76	2.00	188.2	0.81	2.34	157.4	0.84	2.72	129.9	0.88	3.13	108.3	0.92	3.60
260	799.9	0.58	0.82	597.7	0.65	0.99	427.4	0.70	1.29	312.0	0.73	1.69	251.7	0.77	2.01	203.4	0.81	2.34	170.1	0.84	2.72	140.4	0.88	3.14	117.0	0.92	3.61
280	858.2	0.58	0.83	641.3	0.65	0.99	458.7	0.70	1.30	335.0	0.73	1.69	270.4	0.77	2.01	218.5	0.81	2.35	182.7	0.84	2.73	150.9	0.88	3.15	125.8	0.92	3.62
300	916.0	0.59	0.83	684.6	0.65	0.99	489.8	0.70	1.30	357.9	0.73	1.69	289.0	0.77	2.01	233.5	0.81	2.35	195.4	0.84	2.73	161.3	0.88	3.15	134.5	0.92	3.62

Table 6-20.2 - Parabolic waterway design
(Retardance "D" and "B")

V_1 for RETARDANCE "D". Top Width (T), Depth (D) and V_2 for RETARDANCE "C".

Grade 0.50 Percent

Q cfs	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	8.6	1.63	1.58																							
20	11.3	1.58	1.66																							
25	14.1	1.57	1.67	9.0	1.91	2.14																				
30	16.9	1.56	1.68	10.7	1.87	2.21	8.2	2.18	2.48																	
35	19.6	1.55	1.71	12.4	1.85	2.26	9.4	2.10	2.62																	
40	22.4	1.55	1.71	14.1	1.83	2.30	10.7	2.08	2.66																	
45	25.1	1.54	1.73	15.8	1.82	2.33	11.9	2.03	2.76																	
50	27.9	1.54	1.73	17.5	1.80	2.35	13.2	2.02	2.78	9.6	2.42	3.19														
55	30.7	1.54	1.72	19.2	1.80	2.37	14.5	2.02	2.79	10.5	2.39	3.25														
60	33.4	1.54	1.74	20.9	1.79	2.38	15.8	2.01	2.80	11.4	2.37	3.30														
65	36.1	1.53	1.75	22.7	1.80	2.36	17.0	1.99	2.86	12.3	2.35	3.34														
70	38.9	1.54	1.74	24.4	1.80	2.37	18.3	1.99	2.86	13.2	2.33	3.38														
75	41.6	1.54	1.75	26.1	1.[illegible]	2.38	19.6	1.99	2.86	14.1	2.32	3.41	11.2	2.71	3.66											
80	44.3	1.53	1.75	27.8	1.[illegible]	2.39	20.9	1.99	2.86	15.0	2.31	3.43	11.8	2.65	3.80											
90	49.8	1.53	1.75	31.2	1.78	2.41	23.5	1.99	2.87	16.9	2.31	3.42	13.3	2.65	3.78											
100	55.3	1.53	1.75	34.6	1.78	2.42	26.0	1.97	2.90	18.7	2.29	3.47	14.7	2.63	3.85	11.9	3.02	4.13								
110	60.8	1.54	1.75	38.1	1.78	2.41	28.6	1.97	2.90	20.5	2.28	3.50	16.1	2.60	3.90	13.0	2.98	4.22								
120	66.3	1.54	1.75	41.5	1.78	2.42	31.2	1.98	2.90	22.4	2.29	3.49	17.5	2.58	3.94	14.1	2.94	4.30								
130	71.7	1.53	1.76	44.9	1.78	2.42	33.7	1.97	2.92	24.2	2.28	3.51	18.9	2.57	3.98	15.2	2.91	4.36								
140	77.2	1.54	1.76	48.3	1.78	2.43	36.3	1.97	2.92	26.0	2.27	3.54	20.4	2.58	3.95	16.4	2.93	4.34								
150	82.6	1.54	1.76	51.7	1.78	2.43	38.9	1.97	2.91	27.9	2.28	3.52	21.8	2.57	3.98	17.5	2.90	4.39	14.0	3.34	4.77					
160	88.0	1.53	1.76	55.1	1.78	2.44	41.4	1.97	2.93	29.7	2.27	3.54	23.2	2.56	4.01	18.6	2.88	4.44	14.9	3.33	4.80					
170	93.4	1.53	1.77	58.5	1.78	2.44	44.0	1.97	2.92	31.5	2.26	3.55	24.6	2.55	4.03	19.8	2.89	4.41	15.7	3.27	4.92					
180	98.8	1.53	1.77	61.9	1.78	2.44	46.5	1.96	2.94	33.3	2.26	3.57	26.1	2.56	4.01	20.9	2.88	4.45	16.6	3.26	4.94					
190	104.2	1.54	1.77	65.3	1.78	2.44	49.1	1.97	2.93	35.2	2.27	3.55	27.5	2.56	4.03	22.0	2.86	4.49	17.5	3.26	4.96					
200	109.6	1.54	1.77	68.7	1.78	2.44	51.6	1.96	2.94	37.0	2.26	3.56	28.9	2.55	4.04	23.1	2.85	4.52	18.4	3.25	4.98	15.3	3.72	5.23		
220	120.5	1.54	1.77	75.5	1.78	2.44	56.8	1.97	2.93	40.7	2.26	3.56	31.8	2.55	4.04	25.4	2.85	4.53	20.2	3.24	5.01	16.7	3.66	5.36		
240	131.3	1.54	1.77	82.3	1.78	2.45	61.9	1.97	2.94	44.3	2.26	3.58	34.6	2.54	4.07	27.7	2.85	4.53	22.0	3.23	5.04	18.2	3.65	5.38		
260	142.1	1.54	1.77	89.1	1.78	2.45	67.0	1.97	2.94	48.0	2.26	3.58	37.5	2.55	4.06	30.0	2.85	4.54	23.8	3.22	5.06	19.7	3.64	5.39		
280	152.9	1.54	1.78	95.9	1.78	2.45	72.1	1.97	2.95	51.6	2.25	3.59	40.3	2.54	4.08	32.2	2.83	4.58	25.6	3.21	5.08	21.1	3.61	5.48	17.5	4.14	5.75
300	163.7	1.54	1.78	102.6	1.78	2.46	77.2	1.97	2.95	55.3	2.26	3.59	43.2	2.54	4.08	34.5	2.83	4.58	27.3	3.18	5.15	22.6	3.60	5.49	18.7	4.12	5.80

Table 6-20-2 - Parabolic waterway design
(Retardance "D" and "C")

V_1 for RETARDANCE "D". Top Width (T), Depth (D) and V_2 for RETARDANCE "C".

Grade 1.0 Percent

Q cfs	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	13.4	1.13	1.47	8.4	1.30	2.03																				
20	17.8	1.12	1.49	11.1	1.27	2.10	7.6	1.52	2.55																	
25	22.2	1.11	1.50	13.9	1.27	2.09	9.4	1.49	2.64	7.6	1.62	2.99														
30	26.6	1.11	1.50	16.6	1.26	2.13	11.2	1.46	2.71	9.1	1.61	3.03														
35	30.9	1.11	1.52	19.3	1.25	2.15	13.0	1.45	2.75	10.5	1.57	3.14	8.0	1.80	3.59											
40	35.3	1.11	1.52	22.1	1.26	2.13	14.8	1.44	2.79	12.0	1.57	3.14	9.1	1.78	3.65											
45	39.7	1.11	1.52	24.8	1.25	2.15	16.7	1.45	2.76	13.4	1.55	3.21	10.2	1.76	3.70											
50	44.0	1.11	1.52	27.5	1.25	2.16	18.5	1.44	2.79	14.9	1.55	3.21	11.3	1.75	3.74	8.7	2.02	4.20								
55	48.3	1.11	1.53	30.2	1.25	2.16	20.3	1.43	2.80	16.3	1.54	3.26	12.4	1.75	3.76	9.5	1.99	4.30								
60	52.7	1.11	1.52	32.9	1.25	2.17	22.1	1.43	2.82	17.8	1.54	3.25	13.5	1.74	3.79	10.4	2.01	4.26								
65	57.0	1.11	1.53	35.6	1.25	2.17	23.9	1.43	2.83	19.2	1.53	3.29	14.6	1.73	3.81	11.2	1.98	4.33	9.3	2.22	4.66					
70	61.3	1.11	1.53	38.3	1.25	2.17	25.7	1.43	2.84	20.7	1.53	3.27	15.6	1.71	3.90	12.0	1.96	4.40	10.0	2.21	4.69					
75	65.6	1.11	1.53	41.0	1.25	2.18	27.5	1.42	2.85	22.1	1.53	3.31	16.7	1.71	3.90	12.8	1.95	4.46	10.7	2.21	4.71					
80	69.8	1.11	1.54	43.7	1.25	2.18	29.3	1.42	2.85	23.6	1.53	3.29	17.8	1.71	3.91	13.7	1.96	4.42	11.3	2.16	4.85					
90	78.5	1.11	1.54	49.1	1.25	2.18	32.9	1.42	2.87	26.5	1.53	3.31	20.0	1.70	3.93	15.3	1.93	4.52	12.7	2.16	4.87	10.6	2.42	5.20		
100	87.1	1.11	1.54	54.5	1.25	2.18	36.6	1.43	2.85	29.4	1.52	3.32	22.2	1.70	3.94	17.0	1.93	4.52	14.1	2.15	4.89	11.7	2.39	5.31		
110	95.6	1.11	1.54	59.9	1.25	2.18	40.2	1.42	2.86	32.3	1.52	3.33	24.4	1.70	3.94	18.7	1.93	4.52	15.4	2.12	5.00	12.9	2.40	5.28	11.1	2.59	5.67
120	104.2	1.11	1.54	65.2	1.25	2.19	43.8	1.42	2.87	35.2	1.52	3.33	26.6	1.70	3.95	20.3	1.92	4.59	16.8	2.12	5.00	14.0	2.37	5.36	12.1	2.59	5.69
130	112.7	1.11	1.55	70.6	1.25	2.19	47.4	1.42	2.87	38.1	1.52	3.34	28.8	1.70	3.95	22.0	1.92	4.58	18.2	2.13	5.00	15.1	2.35	5.44	13.0	2.55	5.83
140	121.2	1.11	1.55	76.0	1.25	2.19	51.0	1.42	2.87	41.0	1.52	3.34	30.9	1.69	3.99	23.7	1.92	4.57	19.6	2.13	5.00	16.2	2.34	5.50	14.0	2.55	5.83
150	129.7	1.11	1.55	81.3	1.25	2.19	54.6	1.42	2.87	43.9	1.52	3.34	33.1	1.69	3.99	25.3	1.91	4.62	20.9	2.11	5.07	17.4	2.35	5.46	15.0	2.55	5.84
160	138.1	1.11	1.55	86.6	1.25	2.20	58.2	1.42	2.88	46.8	1.52	3.34	35.3	1.69	3.99	27.0	1.91	4.61	22.3	2.11	5.06	18.5	2.33	5.51	15.9	2.52	5.95
170	146.6	1.11	1.55	91.9	1.25	2.20	61.7	1.42	2.89	49.7	1.52	3.34	37.5	1.69	3.99	28.7	1.92	4.60	23.7	2.11	5.05	19.6	2.32	5.56	16.9	2.52	5.94
180	155.0	1.11	1.55	97.2	1.25	2.20	65.3	1.42	2.89	52.5	1.52	3.36	39.6	1.69	4.01	30.3	1.91	4.63	25.0	2.10	5.10	20.7	2.31	5.60	17.9	2.52	5.93
190	163.4	1.11	1.55	102.5	1.25	2.20	68.9	1.42	2.89	55.4	1.52	3.36	41.8	1.69	4.01	32.0	1.91	4.62	26.4	2.10	5.09	21.9	2.32	5.56	18.8	2.50	6.02
200	171.7	1.11	1.56	107.8	1.25	2.20	72.4	1.42	2.90	58.3	1.52	3.35	44.0	1.69	4.00	33.6	1.91	4.65	27.8	2.11	5.08	23.0	2.32	5.59	19.8	2.50	6.01
220	188.7	1.11	1.56	118.4	1.25	2.21	79.6	1.42	2.89	64.0	1.52	3.37	48.4	1.70	4.00	37.0	1.91	4.63	30.5	2.10	5.12	25.3	2.32	5.59	21.7	2.48	6.08
240	205.5	1.11	1.56	129.0	1.25	2.21	86.7	1.42	2.90	69.8	1.52	3.37	52.7	1.69	4.01	40.3	1.91	4.65	33.3	2.10	5.11	27.5	2.30	5.65	23.6	2.47	6.13
260	222.4	1.11	1.56	139.6	1.25	2.21	93.9	1.42	2.90	75.5	1.52	3.38	57.1	1.69	4.01	43.6	1.91	4.66	36.0	2.10	5.14	29.8	2.30	5.64	25.6	2.48	6.11
280	239.1	1.11	1.56	150.2	1.25	2.22	101.0	1.42	2.91	81.3	1.52	3.37	61.4	1.69	4.02	46.9	1.90	4.68	38.8	2.10	5.12	32.1	2.31	5.63	27.5	2.47	6.15
300	255.9	1.11	1.56	160.8	1.25	2.22	108.1	1.42	2.91	87.0	1.52	3.38	65.7	1.69	4.03	50.3	1.91	4.66	41.5	2.10	5.14	34.3	2.30	5.68	29.5	2.48	6.12

Table 6-20.2 - Parabolic waterway design
(Retardance "D" and "C")

V_1 for RETARDANCE "D". Top Width (T), Depth (D) and V_2 for RETARDANCE "C".

Grade 2.0 Percent

Q cfs	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	20.8	0.81	1.32	12.8	0.91	1.90	9.3	1.00	2.37	6.7	1.15	2.85														
20	27.6	0.80	1.33	17.1	0.91	1.89	12.3	0.99	2.43	8.8	1.12	3.00	6.5	1.29	3.51	5.4	1.41	3.84								
25	34.5	0.81	1.33	21.3	0.91	1.91	15.4	0.99	2.43	11.0	1.11	3.01	8.0	1.25	3.69	6.7	1.38	3.96								
30	41.3	0.81	1.34	25.5	0.91	1.92	18.4	0.98	2.46	13.2	1.11	3.02	9.6	1.24	3.71	7.9	1.33	4.20	6.6	1.49	4.48					
35	48.0	0.80	1.35	29.7	0.91	1.93	21.5	0.99	2.44	15.3	1.10	3.08	11.1	1.22	3.82	9.2	1.33	4.23	7.6	1.45	4.68					
40	54.8	0.80	1.34	33.9	0.91	1.93	24.5	0.98	2.46	17.5	1.10	3.07	12.7	1.22	3.81	10.5	1.32	4.26	8.7	1.45	4.67	7.2	1.65	4.96		
45	61.5	0.80	1.35	38.1	0.91	1.93	27.5	0.98	2.47	19.6	1.10	3.11	14.3	1.23	3.80	11.8	1.32	4.27	9.7	1.43	4.80	8.0	1.61	5.16		
50	68.2	0.80	1.35	42.3	0.91	1.93	30.5	0.98	2.48	21.8	1.10	3.09	15.8	1.22	3.86	13.1	1.32	4.28	10.8	1.43	4.78	8.8	1.57	5.33	7.5	1.74	5.64
55	74.9	0.81	1.35	46.4	0.91	1.94	33.5	0.98	2.48	23.9	1.09	3.12	17.4	1.22	3.84	14.4	1.32	4.29	11.8	1.42	4.87	9.7	1.58	5.30	8.2	1.72	5.75
60	81.5	0.81	1.36	50.6	0.91	1.93	36.5	0.98	2.49	26.1	1.10	3.10	18.9	1.21	3.89	15.6	1.30	4.38	12.9	1.42	4.84	10.6	1.59	5.28	9.0	1.74	5.65
65	88.1	0.81	1.36	54.7	0.91	1.94	39.5	0.98	2.49	28.2	1.10	3.12	20.5	1.22	3.87	16.9	1.30	4.38	13.9	1.41	4.92	11.4	1.56	5.40	9.7	1.73	5.74
70	94.7	0.81	1.36	58.8	0.91	1.94	42.5	0.98	2.49	30.3	1.09	3.14	22.0	1.21	3.90	18.2	1.31	4.37	15.0	1.42	4.89	12.3	1.57	5.37	10.4	1.71	5.82
75	101.2	0.81	1.36	62.9	0.91	1.94	45.5	0.99	2.49	32.4	1.09	3.15	23.6	1.22	3.88	19.5	1.31	4.37	16.0	1.41	4.95	13.1	1.55	5.46	11.1	1.70	5.89
80	107.8	0.81	1.36	67.0	0.91	1.95	48.4	0.98	2.50	34.6	1.10	3.13	25.1	1.21	3.91	20.7	1.30	4.42	17.1	1.41	4.91	14.0	1.56	5.43	11.8	1.69	5.95
90	121.0	0.81	1.37	75.2	0.91	1.95	54.4	0.98	2.50	38.8	1.09	3.15	28.2	1.21	3.92	23.3	1.30	4.41	19.2	1.41	4.94	15.7	1.55	5.48	13.3	1.69	5.92
100	134.2	0.81	1.37	83.4	0.91	1.96	60.4	0.99	2.50	43.1	1.10	3.15	31.3	1.21	3.93	25.9	1.30	4.40	21.3	1.41	4.96	17.4	1.55	5.52	14.7	1.68	6.02
110	147.3	0.81	1.37	91.6	0.91	1.96	66.3	0.98	2.51	47.4	1.10	3.15	34.4	1.21	3.93	28.4	1.30	4.44	23.4	1.40	4.98	19.1	1.54	5.55	16.2	1.68	5.99
120	160.3	0.81	1.38	99.8	0.91	1.96	72.2	0.98	2.51	51.6	1.10	3.16	37.5	1.21	3.93	31.0	1.30	4.42	25.5	1.40	4.99	20.8	1.54	5.58	17.6	1.67	6.06
130	173.3	0.81	1.38	107.9	0.91	1.96	78.1	0.98	2.51	55.8	1.09	3.17	40.6	1.21	3.93	33.5	1.30	4.45	27.6	1.40	5.00	22.5	1.53	5.60	19.1	1.68	6.03
140	186.3	0.81	1.38	116.0	0.91	1.97	84.0	0.99	2.52	60.1	1.10	3.16	43.6	1.21	3.96	36.0	1.29	4.47	29.7	1.40	5.00	24.2	1.53	5.62	20.5	1.67	6.08
150	199.2	0.81	1.38	124.1	0.91	1.97	89.9	0.99	2.52	64.3	1.10	3.16	46.7	1.21	3.96	38.6	1.30	4.45	31.8	1.40	5.00	25.9	1.53	5.63	21.9	1.66	6.13
160	212.0	0.81	1.38	132.1	0.91	1.97	95.7	0.99	2.52	68.5	1.10	3.17	49.8	1.21	3.95	41.1	1.30	4.47	33.8	1.40	5.05	27.6	1.53	5.64	23.4	1.67	6.09
170	224.8	0.81	1.39	140.2	0.91	1.97	101.6	0.99	2.52	72.7	1.10	3.17	52.8	1.21	3.97	43.6	1.30	4.48	35.9	1.40	5.05	29.3	1.53	5.65	24.8	1.66	6.13
180	237.5	0.81	1.39	148.2	0.91	1.98	107.4	0.99	2.53	76.8	1.10	3.18	55.9	1.21	3.96	46.2	1.30	4.46	38.0	1.40	5.04	31.0	1.53	5.65	26.3	1.67	6.10
190	250.2	0.81	1.39	156.1	0.91	1.98	113.2	0.99	2.53	81.0	1.10	3.18	58.9	1.21	3.97	48.7	1.30	4.47	40.1	1.40	5.04	32.7	1.53	5.65	27.7	1.67	6.13
200	262.8	0.81	1.39	164.1	0.91	1.98	119.0	0.99	2.53	85.2	1.10	3.18	61.9	1.21	3.98	51.2	1.30	4.48	42.2	1.40	5.03	34.4	1.53	5.66	29.1	1.66	6.16
220	288.5	0.81	1.40	180.2	0.91	1.99	130.7	0.99	2.54	93.6	1.10	3.18	68.1	1.21	3.97	56.3	1.30	4.48	46.3	1.40	5.06	37.8	1.53	5.67	32.0	1.66	6.16
240	314.1	0.81	1.40	196.2	0.91	1.99	142.4	0.99	2.54	102.0	1.10	3.19	74.2	1.21	3.98	61.3	1.30	4.50	50.5	1.40	5.06	41.2	1.53	5.68	34.9	1.66	6.16
260	339.5	0.81	1.40	212.2	0.91	1.99	154.0	0.99	2.54	110.3	1.10	3.20	80.3	1.21	3.98	66.4	1.30	4.49	54.7	1.40	5.05	44.6	1.53	5.68	37.8	1.66	6.16
280	364.9	0.81	1.40	228.2	0.92	1.99	165.6	0.99	2.55	118.7	1.10	3.19	86.3	1.21	4.00	71.4	1.30	4.50	58.8	1.40	5.07	48.0	1.53	5.68	40.6	1.66	6.20
300	390.2	0.81	1.40	244.1	0.92	2.00	177.2	0.99	2.55	127.0	1.10	3.20	92.4	1.21	4.00	76.4	1.30	4.51	63.0	1.40	5.06	51.4	1.53	5.68	43.5	1.66	6.19

Table 6-20.2 - Parabolic waterway design
(Retardance "D" and "C")

V_1 for RETARDANCE "D". Top Width (T), Depth (D) and V_2 for RETARDANCE "C".

Grade 4.0 Percent

Q cfs	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	27.9	0.62	1.29	19.9	0.66	1.68	13.9	0.73	2.20	10.3	0.79	2.73	7.9	0.85	3.28	6.3	0.92	3.78	4.9	1.06	4.21						
20	37.1	0.62	1.29	26.5	0.66	1.69	18.5	0.72	2.21	13.7	0.78	2.76	10.5	0.84	3.33	8.4	0.92	3.81	6.4	1.01	4.52	5.5	1.09	4.88			
25	46.2	0.62	1.30	33.0	0.66	1.70	23.0	0.72	2.24	17.1	0.78	2.77	13.1	0.84	3.35	10.5	0.92	3.82	8.0	1.01	4.55	6.8	1.06	5.09	5.7	1.20	5.34
30	55.3	0.62	1.30	39.5	0.66	1.70	27.6	0.72	2.23	20.4	0.77	2.82	15.7	0.84	3.36	12.5	0.91	3.92	9.5	0.99	4.71	8.2	1.07	5.03	6.7	1.15	5.71
35	64.3	0.62	1.31	46.0	0.66	1.71	32.1	0.72	2.25	23.8	0.78	2.81	18.3	0.84	3.37	14.6	0.91	3.90	11.1	0.99	4.70	9.5	1.06	5.15	7.8	1.15	5.77
40	73.3	0.62	1.31	52.4	0.66	1.71	36.6	0.72	2.25	27.1	0.77	2.83	20.8	0.83	3.42	16.6	0.90	3.96	12.7	1.00	4.68	10.8	1.04	5.24	8.9	1.14	5.81
45	82.2	0.62	1.32	58.8	0.66	1.72	41.1	0.72	2.26	30.4	0.77	2.85	23.4	0.84	3.41	18.7	0.91	3.94	14.2	0.98	4.77	12.2	1.05	5.17	10.0	1.14	5.83
50	91.1	0.62	1.32	65.2	0.66	1.72	45.6	0.72	2.26	33.7	0.77	2.86	26.0	0.84	3.40	20.7	0.90	3.97	15.8	0.99	4.74	13.5	1.05	5.24	11.1	1.14	5.85
55	99.9	0.62	1.32	71.5	0.66	1.73	50.1	0.72	2.26	37.0	0.77	2.86	28.5	0.84	3.43	22.8	0.91	3.95	17.3	0.98	4.80	14.8	1.04	5.28	12.2	1.14	5.87
60	108.7	0.62	1.32	77.8	0.66	1.73	54.5	0.72	2.26	40.3	0.77	2.87	31.0	0.83	3.45	24.8	0.90	3.97	18.9	0.99	4.77	16.1	1.04	5.32	13.3	1.14	5.88
65	117.4	0.62	1.33	84.1	0.66	1.73	58.9	0.72	2.27	43.6	0.77	2.87	33.6	0.84	3.43	26.8	0.90	3.99	20.4	0.98	4.81	17.5	1.05	5.26	14.3	1.12	6.00
70	126.1	0.62	1.33	90.3	0.66	1.74	63.3	0.72	2.27	46.9	0.77	2.86	36.1	0.84	3.44	28.8	0.90	4.01	21.9	0.98	4.85	18.8	1.04	5.29	15.4	1.12	6.00
75	134.7	0.62	1.33	96.5	0.66	1.74	67.7	0.72	2.28	50.1	0.77	2.88	38.6	0.84	3.45	30.9	0.91	3.98	23.5	0.98	4.82	20.1	1.04	5.31	16.5	1.13	5.99
80	143.3	0.62	1.34	102.7	0.66	1.74	72.1	0.72	2.28	53.3	0.77	2.89	41.1	0.84	3.46	32.9	0.91	3.99	25.0	0.98	4.84	21.4	1.04	5.33	17.6	1.13	5.98
90	160.8	0.62	1.34	115.2	0.66	1.75	80.9	0.72	2.28	59.9	0.77	2.89	46.2	0.84	3.46	36.9	0.90	4.01	28.1	0.98	4.85	24.0	1.04	5.38	19.7	1.12	6.07
100	178.2	0.62	1.34	127.7	0.66	1.75	89.7	0.72	2.29	66.4	0.77	2.90	51.2	0.84	3.47	41.0	0.91	4.00	31.2	0.98	4.85	26.7	1.04	5.35	21.9	1.12	6.05
110	195.4	0.62	1.35	140.1	0.66	1.76	98.5	0.72	2.29	72.9	0.77	2.90	56.2	0.84	3.48	45.0	0.90	4.02	34.3	0.98	4.85	29.3	1.04	5.37	24.1	1.12	6.03
120	212.6	0.62	1.35	152.5	0.66	1.76	107.2	0.72	2.30	79.4	0.77	2.90	61.2	0.84	3.49	49.0	0.90	4.03	37.3	0.98	4.88	31.9	1.04	5.40	26.2	1.12	6.09
130	229.6	0.62	1.35	164.8	0.66	1.76	115.9	0.72	2.30	85.9	0.77	2.91	66.2	0.84	3.49	53.0	0.90	4.03	40.4	0.98	4.87	34.6	1.04	5.36	28.4	1.12	6.07
140	246.6	0.62	1.36	177.0	0.66	1.77	124.5	0.72	2.30	92.3	0.77	2.91	71.2	0.84	3.49	57.0	0.90	4.04	43.4	0.98	4.90	37.2	1.04	5.38	30.5	1.12	6.10
150	263.5	0.62	1.36	189.1	0.66	1.77	133.2	0.73	2.30	98.7	0.77	2.92	76.2	0.84	3.49	61.0	0.91	4.04	46.5	0.98	4.88	39.8	1.04	5.39	32.7	1.12	6.08
160	280.3	0.62	1.36	201.2	0.66	1.78	141.7	0.73	2.31	105.1	0.77	2.92	81.1	0.84	3.50	65.0	0.91	4.04	49.5	0.98	4.90	42.4	1.04	5.40	34.8	1.12	6.11
170	296.9	0.62	1.37	213.3	0.67	1.78	150.3	0.73	2.31	111.5	0.78	2.92	86.0	0.84	3.51	68.9	0.91	4.05	52.5	0.98	4.91	45.0	1.04	5.40	36.9	1.12	6.13
180	313.5	0.62	1.37	225.3	0.67	1.78	158.8	0.73	2.32	117.8	0.78	2.93	90.9	0.84	3.52	72.9	0.91	4.05	55.6	0.98	4.90	47.6	1.04	5.40	39.1	1.12	6.11
190	330.0	0.62	1.37	237.2	0.67	1.79	167.3	0.73	2.32	124.2	0.78	2.93	95.8	0.84	3.52	76.8	0.91	4.06	58.6	0.98	4.90	50.2	1.04	5.40	41.2	1.12	6.12
200	346.4	0.62	1.37	249.1	0.67	1.79	175.7	0.73	2.32	130.5	0.78	2.93	100.7	0.84	3.52	80.7	0.91	4.07	61.6	0.98	4.91	52.7	1.04	5.43	43.3	1.12	6.14
220	380.0	0.62	1.38	273.3	0.67	1.79	192.9	0.73	2.33	143.3	0.78	2.93	110.6	0.84	3.53	88.7	0.91	4.07	67.6	0.98	4.93	57.9	1.04	5.44	47.6	1.12	6.14
240	413.3	0.62	1.38	297.4	0.67	1.80	209.9	0.73	2.33	156.0	0.78	2.94	120.4	0.84	3.53	96.6	0.91	4.07	73.7	0.98	4.93	63.1	1.04	5.44	51.9	1.12	6.14
260	446.5	0.62	1.39	321.4	0.67	1.80	227.0	0.73	2.33	168.7	0.78	2.94	130.2	0.84	3.54	104.5	0.91	4.08	79.7	0.98	4.94	68.3	1.04	5.44	56.2	1.12	6.13
280	479.5	0.62	1.39	345.3	0.67	1.80	243.9	0.73	2.34	181.3	0.78	2.95	140.0	0.84	3.54	112.3	0.91	4.09	85.8	0.99	4.93	73.5	1.04	5.44	60.4	1.12	6.15
300	512.3	0.62	1.39	369.0	0.67	1.81	260.8	0.73	2.34	193.9	0.78	2.95	149.8	0.84	3.55	120.2	0.91	4.09	91.8	0.99	4.94	78.6	1.04	5.46	64.7	1.12	6.14

Table 6-20.2 - Parabolic waterway design
(Retardance "D" and "C")

V_1 for RETARDANCE "D". Top Width (T), Depth (D) and V_2 for RETARDANCE "C".

Grade 6.0 Percent

Q cfs	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	34.6	0.53	1.22	22.6	0.57	1.72	16.6	0.61	2.20	12.6	0.65	2.68	10.0	0.70	3.15	8.1	0.76	3.59	6.6	0.82	4.05	5.3	0.90	4.61	4.3	0.98	5.19
20	46.0	0.53	1.22	30.0	0.57	1.73	22.1	0.61	2.20	16.8	0.66	2.68	13.2	0.69	3.25	10.7	0.74	3.71	8.7	0.80	4.22	7.0	0.88	4.79	5.7	0.96	5.36
25	57.2	0.52	1.23	37.4	0.57	1.74	27.6	0.61	2.20	21.0	0.66	2.68	16.5	0.69	3.25	13.3	0.73	3.78	10.8	0.79	4.32	8.7	0.86	4.90	7.0	0.92	5.69
30	68.5	0.53	1.23	44.7	0.57	1.75	33.0	0.61	2.22	25.1	0.66	2.70	19.8	0.69	3.24	16.0	0.74	3.75	13.0	0.80	4.29	10.4	0.86	4.97	8.4	0.92	5.71
35	79.6	0.53	1.24	52.0	0.57	1.76	38.4	0.61	2.22	29.2	0.65	2.71	23.0	0.69	3.28	18.6	0.74	3.78	15.1	0.79	4.34	12.1	0.85	5.01	9.8	0.92	5.72
40	90.6	0.52	1.24	59.3	0.57	1.76	43.8	0.61	2.22	33.3	0.65	2.72	26.3	0.69	3.26	21.2	0.74	3.80	17.2	0.79	4.37	13.8	0.85	5.04	11.2	0.92	5.72
45	101.6	0.53	1.25	66.5	0.57	1.76	49.1	0.61	2.24	37.4	0.66	2.72	29.5	0.69	3.28	23.8	0.73	3.81	19.4	0.79	4.33	15.5	0.85	5.05	12.5	0.91	5.85
50	112.5	0.53	1.25	73.6	0.57	1.77	54.4	0.61	2.24	41.5	0.66	2.72	32.7	0.69	3.29	26.4	0.74	3.82	21.5	0.79	4.35	17.2	0.85	5.06	13.9	0.91	5.83
55	123.3	0.53	1.25	80.8	0.57	1.77	59.7	0.61	2.25	45.5	0.66	2.73	35.9	0.69	3.29	29.0	0.74	3.82	23.6	0.79	4.37	18.8	0.84	5.15	15.3	0.92	5.82
60	134.1	0.53	1.26	87.8	0.57	1.78	65.0	0.61	2.25	49.5	0.66	2.74	39.1	0.69	3.30	31.6	0.74	3.82	25.7	0.79	4.38	20.5	0.84	5.14	16.6	0.91	5.90
65	144.7	0.53	1.26	94.9	0.57	1.78	70.2	0.61	2.26	53.5	0.66	2.75	42.2	0.69	3.32	34.1	0.73	3.85	27.8	0.79	4.38	22.2	0.85	5.14	18.0	0.91	5.87
70	155.3	0.53	1.27	101.9	0.57	1.79	75.4	0.61	2.26	57.5	0.66	2.75	45.4	0.69	3.31	36.7	0.74	3.84	29.9	0.79	4.39	23.9	0.85	5.13	19.3	0.91	5.94
75	165.8	0.53	1.27	108.8	0.57	1.80	80.6	0.61	2.26	61.5	0.66	2.75	48.5	0.69	3.33	39.2	0.73	3.86	31.9	0.79	4.43	25.5	0.84	5.18	20.7	0.91	5.91
80	176.3	0.53	1.27	115.7	0.57	1.80	85.8	0.61	2.27	65.4	0.66	2.76	51.7	0.69	3.32	41.8	0.74	3.85	34.0	0.79	4.42	27.2	0.85	5.16	22.0	0.91	5.96
90	197.6	0.53	1.28	129.8	0.57	1.80	96.2	0.61	2.28	73.4	0.66	2.77	58.0	0.69	3.33	46.9	0.74	3.87	38.2	0.79	4.43	30.5	0.84	5.20	24.8	0.91	5.91
100	218.8	0.53	1.28	143.8	0.57	1.81	106.6	0.61	2.28	81.4	0.66	2.77	64.3	0.69	3.34	52.0	0.74	3.88	42.4	0.79	4.42	33.9	0.85	5.18	27.5	0.91	5.93
110	239.9	0.53	1.28	157.7	0.57	1.81	117.0	0.61	2.28	89.3	0.66	2.78	70.6	0.69	3.35	57.1	0.74	3.88	46.5	0.79	4.45	37.2	0.84	5.20	30.2	0.91	5.95
120	260.8	0.53	1.29	171.5	0.57	1.82	127.3	0.61	2.29	97.2	0.66	2.79	76.9	0.69	3.35	62.2	0.74	3.89	50.7	0.79	4.44	40.5	0.84	5.22	32.9	0.91	5.96
130	281.5	0.53	1.29	185.3	0.57	1.82	137.6	0.61	2.29	105.1	0.66	2.79	83.1	0.69	3.36	67.2	0.74	3.90	54.8	0.79	4.46	43.8	0.84	5.23	35.6	0.91	5.96
140	302.1	0.53	1.30	199.0	0.57	1.83	147.8	0.61	2.30	112.9	0.66	2.80	89.3	0.69	3.36	72.3	0.74	3.90	58.9	0.79	4.46	47.1	0.84	5.24	38.3	0.91	5.97
150	322.6	0.53	1.30	212.6	0.57	1.83	157.9	0.61	2.30	120.7	0.66	2.80	95.5	0.69	3.37	77.3	0.74	3.91	63.0	0.79	4.47	50.4	0.84	5.24	40.9	0.91	6.01
160	342.9	0.53	1.30	226.1	0.57	1.84	168.0	0.61	2.31	128.5	0.66	2.80	101.7	0.69	3.37	82.3	0.74	3.91	67.1	0.79	4.47	53.7	0.85	5.24	43.6	0.91	6.00
170	363.1	0.53	1.31	239.6	0.57	1.84	178.0	0.61	2.32	136.2	0.66	2.81	107.8	0.69	3.37	87.3	0.74	3.91	71.2	0.79	4.47	56.9	0.84	5.27	46.3	0.91	5.99
180	383.1	0.53	1.31	253.0	0.57	1.84	188.0	0.61	2.32	143.9	0.66	2.81	113.9	0.69	3.38	92.2	0.74	3.93	75.2	0.79	4.49	60.2	0.85	5.26	48.9	0.91	6.02
190	403.0	0.53	1.32	266.3	0.57	1.85	197.9	0.61	2.33	151.5	0.66	2.82	120.0	0.70	3.38	97.1	0.74	3.94	79.3	0.79	4.49	63.4	0.84	5.28	51.6	0.91	6.01
200	422.7	0.53	1.32	279.5	0.57	1.85	207.8	0.61	2.33	159.1	0.66	2.82	126.1	0.70	3.39	102.1	0.74	3.93	83.3	0.79	4.50	66.7	0.85	5.27	54.2	0.91	6.03
220	463.4	0.53	1.32	306.6	0.57	1.86	228.0	0.61	2.33	174.6	0.66	2.83	138.4	0.70	3.39	112.0	0.74	3.95	91.5	0.79	4.50	73.2	0.85	5.29	59.6	0.91	6.02
240	503.8	0.53	1.33	333.6	0.57	1.86	248.1	0.61	2.34	190.1	0.66	2.83	150.7	0.70	3.40	122.0	0.74	3.95	99.7	0.80	4.50	79.8	0.85	5.28	64.9	0.91	6.04
260	543.8	0.53	1.33	360.4	0.57	1.86	268.1	0.61	2.34	205.4	0.66	2.84	162.9	0.70	3.40	131.9	0.74	3.96	107.8	0.80	4.51	86.3	0.85	5.29	70.2	0.91	6.05
280	583.6	0.53	1.34	387.0	0.57	1.87	287.9	0.61	2.35	220.7	0.66	2.85	175.1	0.70	3.41	141.8	0.74	3.96	115.9	0.80	4.51	92.8	0.85	5.30	75.5	0.91	6.05
300	623.2	0.53	1.34	413.5	0.58	1.87	307.7	0.61	2.36	235.9	0.66	2.85	187.2	0.70	3.41	151.6	0.74	3.97	123.9	0.80	4.53	99.3	0.85	5.30	80.8	0.91	6.06

Table 6-20.2 - Parabolic waterway design
(Retardance "D" and "C")

V_1 for RETARDANCE "D". Top Width (T), Depth (D) and V_2 for RETARDANCE "C".

Grade 8.0 Percent

Q cfs	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	37.0	0.47	1.26	26.6	0.51	1.65	18.7	0.54	2.19	15.3	0.57	2.54	11.7	0.61	3.08	9.4	0.65	3.61	7.9	0.70	3.99	6.4	0.74	4.62	5.3	0.80	5.18
20	49.2	0.47	1.26	35.3	0.50	1.66	24.9	0.54	2.19	20.4	0.57	2.54	15.6	0.61	3.08	12.5	0.65	3.65	10.4	0.68	4.17	8.5	0.74	4.70	7.1	0.80	5.16
25	61.2	0.47	1.27	44.0	0.50	1.67	31.0	0.54	2.21	[illegible]4	0.57	2.56	19.4	0.61	3.12	15.6	0.65	3.67	13.0	0.68	4.17	10.6	0.73	4.75	8.8	0.79	5.32
30	73.2	0.47	1.28	52.6	0.50	1.67	37.2	0.54	2.19	30.4	0.57	2.57	23.3	0.61	3.10	18.7	0.65	3.67	15.6	0.68	4.17	12.7	0.73	4.77	10.5	0.78	5.41
35	85.1	0.47	1.28	61.2	0.50	1.68	43.2	0.54	2.21	35.3	0.57	2.59	27.1	0.61	3.12	21.7	0.64	3.72	18.1	0.68	4.23	14.8	0.73	4.78	12.2	0.77	5.48
40	96.9	0.47	1.28	69.7	0.50	1.68	49.3	0.54	2.21	40.3	0.57	2.59	30.9	0.61	3.13	24.8	0.64	3.71	20.7	0.68	4.20	16.9	0.73	4.78	13.9	0.77	5.53
45	108.6	0.47	1.29	78.2	0.51	1.68	55.3	0.54	2.22	45.2	0.57	2.60	34.6	0.61	3.16	27.8	0.64	3.73	23.2	0.68	4.24	19.0	0.73	4.78	15.7	0.78	5.45
50	120.2	0.48	1.29	86.5	0.50	1.69	61.2	0.54	2.23	50.0	0.57	2.62	38.4	0.61	3.15	30.9	0.65	3.71	25.8	0.68	4.21	21.0	0.73	4.84	17.4	0.78	5.48
55	131.8	0.48	1.30	94.9	0.51	1.70	67.1	0.54	2.24	54.9	0.57	2.62	42.1	0.61	3.17	33.9	0.65	3.73	28.3	0.68	4.23	23.1	0.73	4.83	19.1	0.78	5.50
60	143.2	0.48	1.30	103.1	0.51	1.70	73.0	0.54	2.24	59.7	0.57	2.62	45.9	0.61	3.16	36.9	0.65	3.73	30.8	0.68	4.24	25.1	0.73	4.87	20.8	0.78	5.51
65	154.6	0.48	1.30	111.4	0.51	1.71	78.9	0.54	2.24	64.5	0.57	2.63	49.6	0.61	3.16	39.9	0.65	3.74	33.3	0.68	4.25	27.2	0.73	4.85	22.5	0.78	5.52
70	165.9	0.48	1.31	119.5	0.51	1.71	84.7	0.54	2.25	69.3	0.57	2.63	53.2	0.61	3.19	42.8	0.64	3.76	35.8	0.68	4.26	29.2	0.73	4.88	24.1	0.77	5.59
75	177.1	0.48	1.31	127.6	0.51	1.72	90.5	0.54	2.25	74.1	0.57	2.63	56.9	0.61	3.19	45.8	0.65	3.76	38.2	0.68	4.29	31.2	0.73	4.90	25.8	0.77	5.59
80	188.2	0.48	1.32	135.6	0.51	1.72	96.2	0.54	2.26	78.8	0.57	2.64	60.5	0.61	3.20	48.7	0.64	3.78	40.7	0.68	4.29	33.3	0.73	4.87	27.5	0.77	5.58
90	210.9	0.48	1.32	152.1	0.51	1.73	108.0	0.55	2.26	88.4	0.57	2.65	67.9	0.61	3.21	54.7	0.65	3.78	45.7	0.68	4.29	37.4	0.73	4.88	30.9	0.77	5.59
100	233.5	0.48	1.32	168.4	0.51	1.73	119.6	0.55	2.27	98.0	0.57	2.65	75.3	0.61	3.21	60.7	0.65	3.78	50.6	0.68	4.32	41.4	0.73	4.92	34.2	0.77	5.64
110	255.9	0.48	1.33	184.6	0.51	1.74	131.2	0.55	2.28	107.5	0.57	2.66	82.6	0.61	3.22	66.6	0.65	3.79	55.6	0.68	4.32	45.5	0.73	4.91	37.6	0.77	5.63
120	278.1	0.48	1.33	200.7	0.51	1.74	142.7	0.55	2.28	116.9	0.57	2.67	89.9	0.61	3.22	72.5	0.65	3.79	60.5	0.68	4.33	49.5	0.73	4.93	40.9	0.77	5.66
130	300.2	0.48	1.34	216.6	0.51	1.75	154.1	0.55	2.29	126.4	0.57	2.67	97.1	0.61	3.24	78.3	0.65	3.81	65.4	0.68	4.34	53.6	0.73	4.92	44.3	0.77	5.64
140	322.1	0.48	1.34	232.5	0.51	1.76	165.5	0.55	2.29	135.7	0.57	2.67	104.4	0.62	3.23	84.2	0.65	3.81	70.3	0.68	4.34	57.6	0.73	4.93	47.6	0.77	5.66
150	343.9	0.48	1.34	248.3	0.51	1.76	176.8	0.55	2.30	145.0	0.57	2.68	111.5	0.61	3.25	90.0	0.65	3.82	75.2	0.68	4.35	61.6	0.73	4.94	50.9	0.77	5.67
160	365.5	0.48	1.35	264.0	0.51	1.76	188.1	0.55	2.30	154.3	0.57	2.68	118.7	0.62	3.25	95.8	0.65	3.82	80.0	0.68	4.36	65.6	0.73	4.94	54.2	0.77	5.68
170	386.9	0.48	1.35	279.6	0.51	1.77	199.3	0.55	2.31	163.5	0.57	2.69	125.8	0.62	3.26	101.6	0.65	3.82	84.8	0.68	4.37	69.5	0.73	4.97	57.5	0.77	5.69
180	408.2	0.48	1.36	295.1	0.51	1.77	210.4	0.55	2.31	172.7	0.57	2.69	132.8	0.62	3.27	107.3	0.65	3.84	89.7	0.68	4.36	73.5	0.73	4.96	60.8	0.77	5.69
190	429.3	0.48	1.36	310.5	0.51	1.78	221.4	0.55	2.32	181.8	0.57	2.70	139.9	0.62	3.27	113.0	0.65	3.84	94.4	0.68	4.38	77.4	0.73	4.98	64.0	0.77	5.71
200	450.2	0.48	1.36	325.7	0.51	1.78	232.4	0.55	2.32	190.8	0.57	2.71	146.9	0.62	3.28	118.7	0.65	3.85	99.2	0.68	4.39	81.4	0.73	4.97	67.3	0.77	5.71
220	493.4	0.48	1.37	357.1	0.51	1.79	254.9	0.55	2.33	209.4	0.58	2.71	161.1	0.62	3.29	130.3	0.65	3.85	108.9	0.68	4.39	89.3	0.73	4.99	73.9	0.77	5.72
240	536.2	0.48	1.37	388.3	0.51	1.79	277.3	0.55	2.34	227.8	0.58	2.71	175.4	0.62	3.29	141.8	0.65	3.86	118.6	0.68	4.40	97.3	0.74	4.99	80.5	0.77	5.72
260	578.8	0.48	1.38	419.3	0.51	1.80	299.5	0.55	2.34	246.2	0.58	2.72	189.5	0.62	3.30	153.3	0.65	3.87	128.2	0.68	4.40	105.2	0.74	5.00	87.0	0.77	5.74
280	621.1	0.48	1.38	450.1	0.51	1.80	321.6	0.55	2.35	264.4	0.58	2.72	203.6	0.62	3.31	164.8	0.65	3.87	137.8	0.68	4.41	113.1	0.74	5.00	93.5	0.77	5.76
300	663.1	0.48	1.39	480.7	0.51	1.81	343.6	0.55	2.35	282.6	0.58	2.73	217.6	0.62	3.31	176.1	0.65	3.88	147.4	0.69	4.41	120.9	0.74	5.02	100.1	0.78	5.75

Table 6-20.2 - Parabolic waterway design
(Retardance "D" and "C")

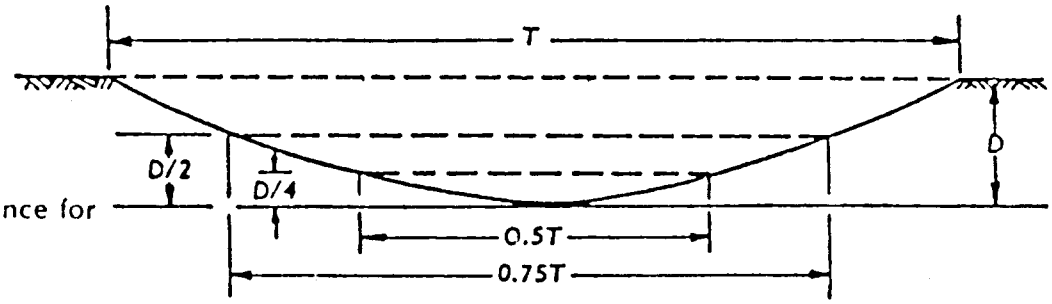
V_1 for RETARDANCE "D". Top Width (T), Depth (D) and V_2 for RETARDANCE "C".

Grade 10.0 Percent

Q cfs	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	45.2	0.43	1.14	32.5	0.45	1.50	22.9	0.49	1.98	16.6	0.52	2.56	13.4	0.55	2.99	10.7	0.58	3.55	9.0	0.61	3.99	7.4	0.65	4.57	6.2	0.70	5.08
20	60.1	0.43	1.14	43.2	0.45	1.50	30.4	0.49	2.00	22.1	0.52	2.56	17.8	0.55	3.02	14.3	0.59	3.52	12.0	0.61	4.00	9.9	0.65	4.55	8.3	0.70	5.06
25	74.8	0.43	1.15	53.8	0.45	1.51	37.9	0.49	2.00	27.5	0.52	2.59	22.3	0.55	2.99	17.8	0.58	3.56	14.9	0.61	4.08	12.3	0.65	4.63	10.3	0.69	5.18
30	89.3	0.43	1.15	64.2	0.45	1.52	45.3	0.49	2.01	33.0	0.52	2.58	26.6	0.55	3.03	21.3	0.58	3.58	17.9	0.61	4.05	14.7	0.64	4.68	12.4	0.70	5.13
35	103.7	0.43	1.16	74.6	0.45	1.53	52.6	0.48	2.03	38.3	0.52	2.60	31.0	0.55	3.02	24.8	0.58	3.59	20.8	0.61	4.09	17.2	0.65	4.63	14.4	0.69	5.19
40	118.0	0.43	1.16	85.0	0.46	1.53	59.9	0.48	2.04	43.7	0.52	2.60	35.3	0.55	3.04	28.3	0.58	3.59	23.8	0.61	4.06	19.6	0.65	4.66	16.4	0.69	5.24
45	132.2	0.43	1.17	95.2	0.45	1.53	67.2	0.49	2.04	49.0	0.52	2.61	39.6	0.55	3.05	31.7	0.58	3.62	26.7	0.61	4.08	22.0	0.65	4.68	18.4	0.69	5.27
50	146.3	0.43	1.17	105.3	0.45	1.54	74.4	0.49	2.04	54.3	0.52	2.61	43.9	0.55	3.05	35.2	0.58	3.61	29.6	0.61	4.09	24.4	0.65	4.68	20.4	0.69	5.28
55	160.2	0.43	1.17	115.4	0.46	1.55	81.5	0.49	2.06	59.5	0.52	2.63	48.2	0.55	3.05	38.6	0.58	3.62	32.4	0.61	4.13	26.7	0.64	4.74	22.4	0.69	5.29
60	174.0	0.43	1.18	125.3	0.46	1.55	88.6	0.49	2.06	64.7	0.52	2.63	52.4	0.55	3.07	42.0	0.58	3.63	35.3	0.61	4.12	29.1	0.65	4.73	24.4	0.69	5.30
65	187.6	0.43	1.18	135.2	0.46	1.56	95.6	0.49	2.07	69.9	0.52	2.64	56.6	0.55	3.08	45.4	0.58	3.64	38.2	0.61	4.12	31.5	0.65	4.72	26.4	0.69	5.30
70	201.2	0.43	1.19	145.0	0.46	1.57	102.6	0.49	2.08	75.1	0.52	2.64	60.8	0.55	3.08	48.7	0.58	3.66	41.0	0.61	4.14	33.8	0.65	4.75	28.4	0.69	5.29
75	214.6	0.43	1.19	154.7	0.46	1.57	109.6	0.49	2.08	80.2	0.52	2.65	65.0	0.55	3.08	52.1	0.58	3.66	43.8	0.61	4.15	36.2	0.65	4.74	30.3	0.69	5.34
80	227.9	0.43	1.20	164.3	0.46	1.58	116.4	0.49	2.09	85.3	0.52	2.65	69.1	0.55	3.09	55.4	0.58	3.67	46.6	0.61	4.16	38.5	0.65	4.76	32.3	0.69	5.33
90	255.2	0.43	1.20	184.1	0.46	1.58	130.5	0.49	2.10	95.6	0.52	2.67	77.5	0.55	3.11	62.1	0.58	3.69	52.3	0.61	4.17	43.2	0.65	4.78	36.3	0.69	5.33
100	282.4	0.43	1.20	203.7	0.46	1.59	144.5	0.49	2.10	105.9	0.52	2.67	85.9	0.56	3.11	68.8	0.58	3.70	58.0	0.61	4.18	47.9	0.65	4.78	40.2	0.69	5.36
110	309.2	0.43	1.21	223.2	0.46	1.60	158.4	0.49	2.11	116.2	0.52	2.68	94.3	0.56	3.11	75.5	0.58	3.71	63.7	0.61	4.18	52.6	0.65	4.79	44.2	0.69	5.34
120	335.9	0.43	1.21	242.4	0.46	1.60	172.2	0.49	2.12	126.4	0.52	2.68	102.5	0.56	3.12	82.2	0.58	3.71	69.3	0.61	4.19	57.3	0.65	4.79	48.1	0.69	5.36
130	362.3	0.43	1.22	261.6	0.46	1.61	185.9	0.49	2.12	136.5	0.52	2.69	110.8	0.56	3.13	88.8	0.58	3.72	74.9	0.61	4.20	61.9	0.65	4.81	52.0	0.69	5.37
140	388.4	0.44	1.22	280.5	0.46	1.61	199.5	0.49	2.13	146.5	0.52	2.70	119.0	0.56	3.13	95.4	0.58	3.73	80.5	0.61	4.20	66.5	0.65	4.82	55.9	0.69	5.38
150	414.4	0.44	1.23	299.3	0.46	1.62	213.0	0.49	2.13	156.5	0.52	2.71	127.1	0.56	3.14	101.9	0.58	3.74	86.0	0.61	4.22	71.1	0.65	4.83	59.7	0.69	5.41
160	440.1	0.44	1.23	318.1	0.46	1.62	226.5	0.49	2.14	166.4	0.53	2.71	135.2	0.56	3.15	108.4	0.58	3.75	91.6	0.62	4.21	75.7	0.65	4.83	63.6	0.69	5.41
170	465.5	0.44	1.24	336.7	0.46	1.63	239.8	0.49	2.14	176.3	0.53	2.72	143.3	0.56	3.15	114.9	0.58	3.76	97.1	0.62	4.22	80.3	0.65	4.83	67.4	0.69	5.42
180	490.8	0.44	1.24	355.1	0.46	1.63	253.1	0.49	2.15	186.1	0.53	2.73	151.3	0.56	3.16	121.3	0.58	3.77	102.5	0.62	4.24	84.9	0.65	4.83	71.3	0.69	5.42
190	515.7	0.44	1.25	373.5	0.46	1.64	266.3	0.49	2.15	195.9	0.53	2.73	159.3	0.56	3.17	127.7	0.58	3.78	108.0	0.62	4.24	89.4	0.65	4.84	75.1	0.69	5.43
200	540.5	0.44	1.25	391.6	0.46	1.64	279.4	0.49	2.16	205.6	0.53	2.74	167.2	0.56	3.17	134.1	0.58	3.79	113.4	0.62	4.25	93.9	0.65	4.85	78.9	0.69	5.43
220	592.0	0.44	1.26	429.2	0.46	1.65	306.3	0.49	2.17	225.4	0.53	2.75	183.5	0.56	3.18	147.1	0.58	3.80	124.4	0.62	4.26	103.1	0.65	4.85	86.6	0.69	5.45
240	643.0	0.44	1.26	466.4	0.46	1.65	333.1	0.49	2.17	245.2	0.53	2.75	199.6	0.56	3.19	160.0	0.58	3.81	135.4	0.62	4.27	112.2	0.65	4.87	94.3	0.69	5.45
260	693.6	0.44	1.27	503.4	0.46	1.66	359.6	0.49	2.18	264.8	0.53	2.76	215.6	0.56	3.19	172.9	0.58	3.82	146.4	0.62	4.27	121.3	0.65	4.87	101.9	0.69	5.47
280	743.7	0.44	1.27	540.0	0.46	1.66	386.0	0.49	2.18	284.4	0.53	2.77	231.6	0.56	3.20	185.8	0.59	3.82	157.3	0.62	4.28	130.4	0.65	4.88	109.6	0.69	5.47
300	793.4	0.44	1.28	576.4	0.46	1.67	412.3	0.49	2.19	303.8	0.53	2.77	247.5	0.56	3.21	198.6	0.59	3.83	168.1	0.62	4.29	139.4	0.65	4.89	117.2	0.69	5.48

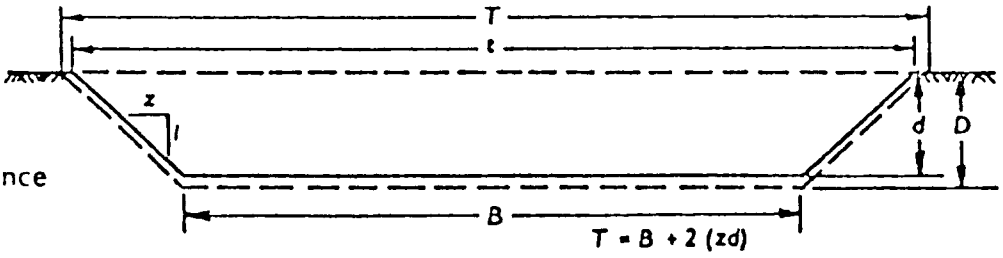
Table 6-20.2 - Parabolic waterway design
(Retardance "D" and "C")

T = design top width
D = design depth
Both values include allowance for the vegetative lining.



PARABOLIC CROSS SECTION

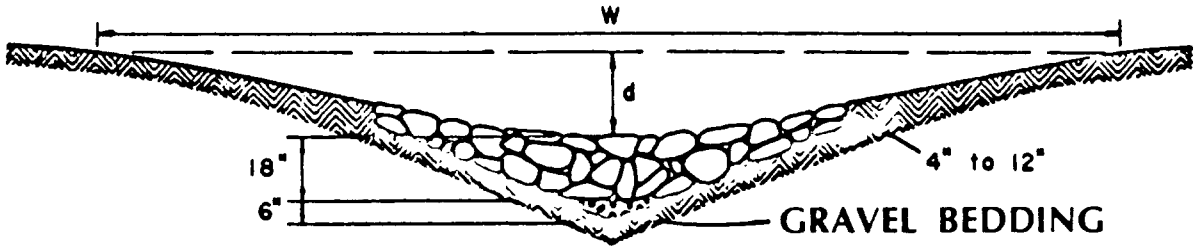
B = design bottom width
d = design depth
D = design depth plus allowance for vegetative lining
t = design top width
T = design top width plus allowance for vegetative lining
z = side slope ratio



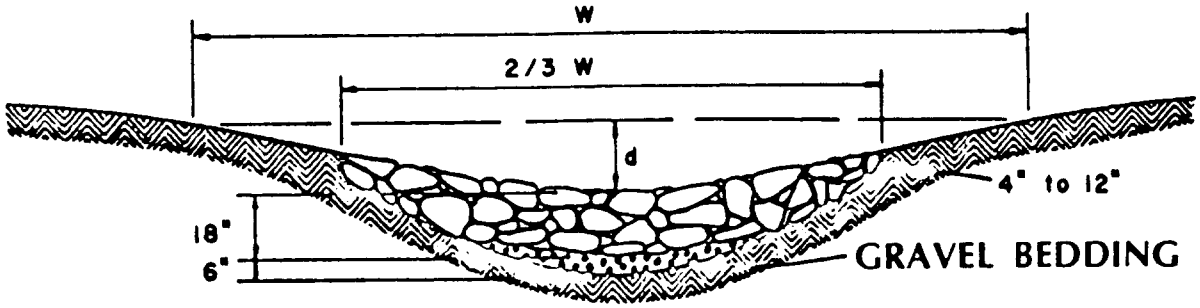
TRAPEZOIDAL CROSS SECTION

Figure 6-20.1 - Typical Waterway Cross Section

STONE CENTER WATERWAYS



Waterway with stone center drain
V section shaped by motor patrol

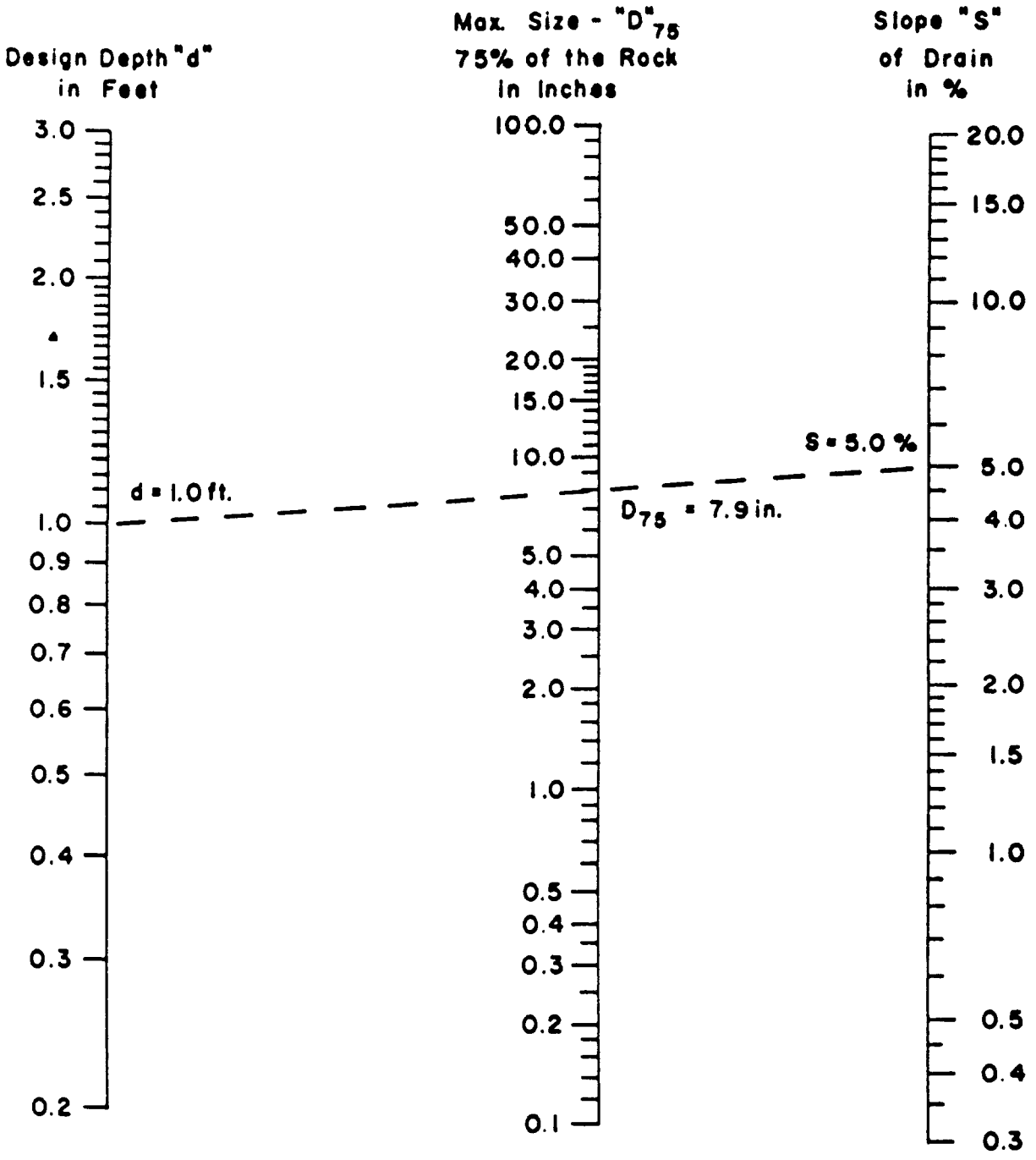


Waterway with stone center drain
Rounded section shaped by bulldozer

Figure 6-20.2 - Waterway with stone center.

	Grade 6	Percent	Grade 8	Percent	Grade 10	Percent	Grade 12	Percent	Grade 15	Percent
V	8.0	10	8.0	10	8.0	10.0	8.0	10.0	8.0	10.0
D	1.3	1.6	1.1	1.3	1.0	1.2	0.9	1.1	0.8	0.9
Q	Top Widths									
20							5		5	
25					5		6		6	4
30			5		6		7		7	5
35			6		7		8	5	8	6
40	6		7		8	5	9	6	10	7
45	7		8		9	6	10	6	11	7
50	7		9	6	10	7	11	7	12	8
55	8		9	6	11	7	12	8	13	9
60	9		10	7	12	8	13	8	14	9
65	9		11	7	12	9	14	9	16	11
70	10	7	12	8	13	9	15	10	17	11
75	11	7	13	9	14	10	16	10	18	12
80	12	8	14	9	15	10	18	11	19	13
90	13	9	15	10	17	12	20	13	21	15
100	14	10	17	11	19	13	22	14	24	16
110	16	11	19	13	21	14	24	15	26	18
120	17	11	21	14	23	16	26	17	29	20
130	19	12	22	15	25	17	29	18	31	21
140	20	13	24	16	27	18	31	19	33	23
150	22	14	26	17	29	20	33	21	36	24
160	23	15	27	18	31	21	35	22	38	26
170	25	16	29	19	33	22	37	24	40	28
180	26	17	31	20	34	23	39	25	43	29
190	27	18	32	22	36	25	42	26	45	31
200	29	19	34	23	38	26	44	28	47	33
220	32	21	38	25	42	29	48	31	52	38
240	35	23	41	27	46	31	53	33	57	39
260	38	25	44	30	50	34	57	36	62	42
280	40	27	48	32	54	36	61	39	67	45
300	43	29	51	34	57	39	66	42	71	49

Table 6-20.3 - Velocity, Top Width and Depth for Parabolic Stone Center Waterways



EXAMPLE: "d" = 1.0 Feet "S" = 5%

Place straight edge at "d" value in Design Depth column and at "S" value in Slope column. Read rock size in middle column 7.9 inches. Say 8 inches.

FOR DESIGN:

25% of the rock by volume should be in sizes of 8 inches or slightly larger. The remaining 75% or less should be of well graded material, smaller than 8 inches, including sufficient sands and gravels to fill the voids between the larger rock.

Figure 6-20.3 - Determination of rock size for stone center waterway.

Buffer Zone

Bf

DEFINITION

A strip of undisturbed, original land or vegetation surrounding the land-disturbing site, or bordering streams.

PURPOSE

To provide a buffer zone serving one or more of the following purposes:

- Reduce storm runoff velocities.
- Filter sediment in runoff water.
- Act as screen for "vision pollution."
- Reduce construction noise.
- Improve aesthetics on the land disturbed.

CONDITIONS

Generally, a natural strip of vegetation should be preserved and, if needed, supplemented to form the buffer zone. Refer to the minimum requirements in Act 599 (O.C.G.A. 12-7-1 et seq.).

Where necessary, a buffer zone may be installed sing the Vegetative Practices included in this manual.

In most cases, the buffer zone will be incorporated into the permanent vegetative cover.

DESIGN CONDITIONS

A width should be selected to permit the zone to serve the purpose(s) as listed above. Supplemental plantings may be used to increase the effectiveness of the buffer zone.

Coastal Dune Stabilization (With Vegetation)

Cs

DEFINITION

Planting vegetation on dunes that are denuded, artificially constructed, or re-nourished.

PURPOSE

To stabilize soil on dunes allowing them to become more resistant to wind and waves, and to allow development of dunes in areas where they have been damaged or destroyed.

CONDITIONS

On bare or sparsely vegetated dunes or areas where dune development is desired.

PLANNING CONSIDERATIONS

1. Coastal beaches are subject to regulation from a variety of Federal, State, and local agencies. Permits must be requested and granted by all appropriate jurisdictions before work is performed.

2. Coastal areas are affected by many dynamic systems. Detailed studies are often required to determine the possible effects that may result from dune modifications. Environmental assessments are generally required including public review and comment.

3. Protection of dunes from human and vehicular traffic is essential if vegetation is to succeed. Crosswalks or crossover structures should be planned to provide beach access.

4. Plant species that are native to coastal areas should be used whenever possible.

5. An irrigation system will be required during the first growing season in order to obtain good survival.

6. Vegetation: Commercially available plants include the following:

   a. Marshhay cordgrass (Spartina patens) "Flageo" variety or native collections.
   Marshhay cordgrass is a perennial grass that occurs on dunes throughout the South Atlantic and Gulf region and in Puerto Rico. It is the dominant plant on dunes composed of broken shale and coquina rock along the northern Florida coast. The grass is especially tolerant of salt.

   Stems are slender and grow two to three feet tall. Leaves are rolled inward and resemble rushes. Seed heads are composed of two to several compressed spikes attached at about 90 degrees to the culm. Plants spread by means of a network of slender rhizomes.

   Plantings of vegetative material in early spring are most successful. Bare root or potted planting stock is recommended for large plantings. Stems rooted at the base can be planted at a depth of four to five inches deep. Plants that have developed rhizomes are preferred for planting stock.

   b. Bitter panicum (Panicum amarum)

   Bitter panicum is a perennial grass found on dunes throughout the South Atlantic and Gulf regions. It is most common in South Florida and Texas.

   Plants grow to an average height of three to four feet tall. Leaves are smooth and bluish green color. Seed heads are narrow, compressed, and generally are sparsely seeded. Plants spread from a very aggressive, scattered system of rhizomes, but stands are rather open.

   Bitter panicum produces few viable seed but is easier to transplant than sea oats. They can be propagated from a stem with part of the rhizome attached or from rhizomes that are eight to twelve inches long. Plant rhizomes about four inches deep in early spring.

   Plants may be propagated by removing all of the stem from robust plants and placing them in the dune at an angle of about 45 degrees. Several nodes should be buried. Spacing should be no more than six feet apart.

c. Coastal Panicgrass (Panicum amarum v. amaralum)

Coastal panicgrass is a somewhat dense, upright perennial bunchgrass found on coastal dunes throughout the South Atlantic and Gulf area. It is the dominant plant at many locations in, West Florida, Alabama, and Texas.

The stems are coarse, straight, stiff, and up to four feet tall. Partially compressed seed heads produce moderate amounts of viable seed each fall. The crowns enlarge slowly from short, almost vertical tillers.

Plant seed one to three inches deep and mulch the area. Seedling survival depends on adequate moisture after germination. Clumps of coastal panicgrass can be dug, divided and planted during rainy seasons or when irrigation is available.

Sand Fence Use In Building Dunes

Sand fence may be used to build sand dunes when sand is available. Costs are usually higher but dune development is faster when compared to vegetation alone and generally less expensive than building dunes with machinery.

To form a barrier dune, construct sand fences a minimum of 100 feet from the mean high tide line. Two or more parallel fences spaced from 30 to 40 feet apart are needed. Locate fences as near as possible to a 90 degree angle with toe prevailing winds, but as near parallel to the water line as possible.

Where winds are generally parallel with the water line, a single line of fence may be constructed at least 140 feet from the mean high tide. Construct short sections of fence (approximately 30 feet long) parallel to the prevailing wind and approximately perpendicular to the original fence. Place these fences opposite the water side and space these fences about 40 feet apart.

As sand collects over the fence, additional fence can be constructed over the original fence until the desired height is obtained.

Old dunes may be widened by constructing sand fence about 15 feet to the seaward side of the base of the old dune.

Vegetation must be established following development of dune, or allowed to develop from existing stands as dunes develop.

SPECIFICATIONS

Sand Fence Specifications

Use standard commercial 4-foot high snow fence that consists of wooden slats wired together with spaces between the slats. Distance between slats is approximately equal to the slat width, or generally 1 1/4 inches. Slats will be made from grade A or better spruce. Slats will be woven between five two-wire cables of copper-bearing, galvanized wire. Slats will be dipped in a red oxide, weather resistant stain. The fence must be sound, free of decay, broken wire or missing or broken slats.

Fence will be supported by black locust, red cedar, or white cedar posts. Other wood of equal life or strength may be used. Posts will be a minimum of 7' with a minimum diameter of three inches. Posts will be spaced no farther than 10 feet apart.

Four wire ties will be used to fasten fence to posts. Weave fence between posts so that every other post will be attached on the ocean side of posts. Tie wires will be no smaller than 12-gauge galvanized wire.

Posts will be set in holes at least three feet deep.

Three or four rows of fence should be used if sufficient land area and sand is available.

MAINTENANCE

Maintaining Dunes

A strong, uniform dune line must be maintained to provide maximum protection from wind and water. Blow-outs, wash pits, or other natural or man-made damage must be repaired quickly in order to prevent weakening the entire system. Blow-outs in a dune system can be repaired by placing sand fence between existing dunes. One or more fences may be required. It is essential to tie the ends of the fence into the existing dune to keep the wind from slipping around the ends. Maintain fences, and erect additional fences if needed, until the eroding area is replenished to the desired height and permanently stabilized.

Foot and vehicular traffic must be controlled or prohibited on dunes in order to maintain vegetation and prevent excessive sand movement. Elevated walks, semi-permanent paved paths, and portable roll-up walkways are satisfactory. Walkways should be curved to reduce wind movement. Both inland and secondary dunes must be protected from traffic.

Vegetative Maintenance

Plantings are maintained with applications of fertilizer applied to keep desired density of plants. Annual application of about 50 pounds of nitrogen per acre should be applied. Where vegetation has been destroyed, replanting should be considered.

Disturbed Area Stabilization (With Mulching Only)

Ds1

DEFINITION

Applying plant residues or other suitable materials not produced on the site to the soil surface.

PURPOSE

To reduce runoff and erosion; conserve moisture, prevent surface compaction or crusting; to control undesirable vegetation; to modify soil temperature; to increase biological activity in the soil.

SPECIFICATIONS

A. For temporary protection of critical areas without seeding.

This standard applies to grades or cleared areas which may be subjected to erosion for 6 months or less, where seedings may not have a suitable growing season to produce an erosion retardant cover, *but which can be stabilized with a mulch cover.*

Site Preparation

1. Grade, as needed and feasible, to permit the use of equipment for applying and anchoring mulch.
2. Install needed erosion control measures as required such as dikes, diversions, berms, terraces and sediment barriers.
3. As needed and feasible loosen compact soil to a minimum depth of 3 inches.

Mulching Materials

1. Dry straw or hay — spread at a rate of 2 1/2 tons per acre.
2. Wood waste, chips, sawdust or bark— spread 2 to 3 inches deep (about 6 to 9 tons per acre).
3. Erosion control matting or netting, such as excelsior, jute, textile and plastic matting and netting — applied in accordance with manufacturers recommendations.
4. Cutback asphalt, slow curing — applied at 1200 gallons per acre (or 1/4 gallon per sq. yd.)
5. Polyethylene film — secured over banks or stockpiled soil material for temporary protection.

Applying and Anchoring Mulch

1. Apply straw or hay mulch uniformly by hand or mechanically. Anchor as appropriate and feasible. It may be pressed into the soil with a disk harrow with the disk set straight or with a special "packer disk." The disk may be smooth or serrated and should be 20 inches or more in diameter and 8 to 12 inches apart. The edges of the disk should be dull enough not to cut the mulch but to press it into the soil leaving much of it in an erect position.

   Straw hay mulch spread with special blower-type equipment may be anchored with emulsified asphalt (Grade AE-5 or SS-1). The asphalt emulsion must be sprayed onto the mulch as it is ejected from the machine. Use 100 gallons of water per ton of mulch.
2. Spread wood waste uniformly on slopes that are 3:1 and flatter. No anchoring is needed.
3. Commercial matting and netting. Follow manufacturer's specification included with the material.
4. Apply asphalt so area has uniform appearance. (Note: Use in areas of pedestrian traffic could cause problems of "tracking in" or damage to shoes, clothing, etc.)

B. To conserve moisture and control weeds in nurseries, ornamental beds, around shrubs, and on bare areas on lawns.

Mulching materials

Use one of the materials given below and apply at thickness indicated.

Material	Depth
1. Grain straw or grass hay	6" to 10"
2. Pine needles	4" to 6"
3. Wood waste (sawdust, bark, chips)	4" to 8"
4. Shredded residues (crops, leaves, etc.)	4" to 8"

5. Completely cover area with black polyethylene film and hold in place by placing soil on the outer edge.

When using organic mulches, apply 20-30 pounds of nitrogen in addition to the normal amount needed for plant growth to offset the tie up of N by decomposition of mulch.

Disturbed Area Stabilization (With Temporary Seedings)

Ds2

DEFINITION

Establishing temporary vegetative cover with fast growing seedings on disturbed or denuded areas.

PURPOSE

— To reduce erosion, sediment and runoff damages to downstream resources.
— To improve wildlife habitat.
— To improve aesthetics.
— To improve safety and public road rights-of-way.
— To improve tilth and add organic matter for permanent plantings.

CONDITIONS

This practice is applicable on areas subject to erosion for up to twelve months or until establishment of finished grade or permanent vegetative cover. Temporary vegetative measures should be coordinated with permanent measures to assure economical and effective stabilization.

SPECIFICATIONS

A. Grading and Shaping

1. Excessive water run-off must be controlled by planned and installed erosion control practices such as closed drains, ditches, dikes, diversions, sediment basins and others.
2. No shaping or grading is required if slopes can be stabilized by hand-seeded vegetation or if hydraulic seeding equipment is to be used.

B. Seedbed Preparation

1. When a hydraulic seeder is used, seedbed preparation is not required.
2. When using conventional or hand-seeding, seedbed preparation is not required if the soil material is loose and not sealed by rainfall.
3. When soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, the soil shall be pitted, trenched or otherwise scarified to provide a place for seed to lodge and germinate.

C. Lime and Fertilizer

1. Agricultural lime is not required.
2. On reasonably fertile soils or soil material, fertilizer is not required.
3. On soils of very low fertility, use 500 to 700 pounds of 10-10-10 fertilizer or the equivalent per acre (12-16 lbs./1,000 sq. ft.). If the site will permit, apply before land preparation and disk, rip or chisel to incorporate.

D. Seeding

1. Select a grass or grass-legume mixture suitable to the area and season of the year.
2. Apply seed uniformly by hand, cyclone seeder, drill, cultipacker-seeder, or hydraulic seeder (slurry including seed and fertilizer). Drill or cultipacker seeders should normally place seed one-half to one inch deep.

E. Mulching

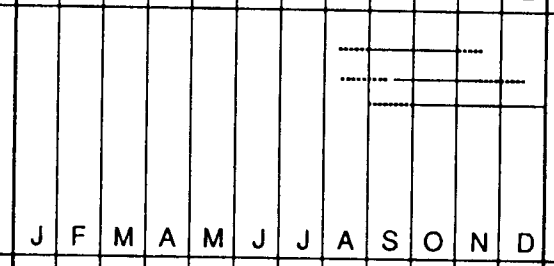
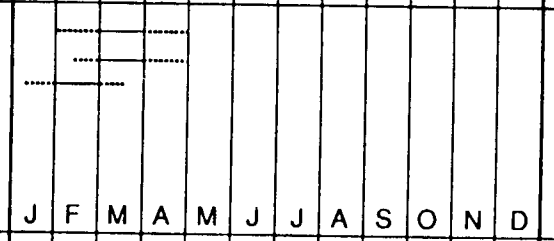
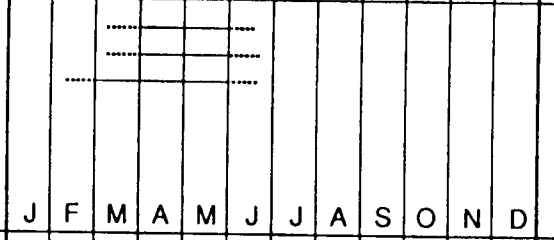
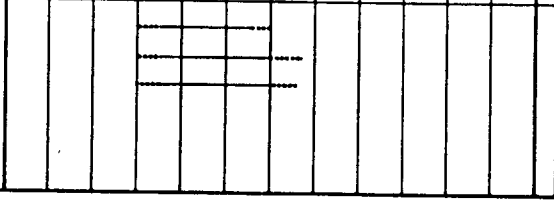
Temporary vegetation can, in most cases, be established without the use of mulch. Mulch without seeding should be considered for short term protection. See Ds1 - Disturbed Area Stabilization, (With Mulching Only).

F. Irrigation

If water is applied, it must be at a rate not causing runoff and erosion. Thoroughly wet the soil to a depth that will insure germination of the seed. Subsequent applications should be made when needed.

Table 6-24.1

PLANTS, PLANTING RATES, AND PLANTING DATES FOR TEMPORARY COVER OR COMPANION CROPS 1/

Species	Broadcast Rates 2/ - PLS 3/ Per Acre	Broadcast Rates 2/ - PLS 3/ Per 1000 sq. ft.	Resource Area	Planting Dates by Resource Areas — Planting Dates (Solid lines indicate optimum dates, dotted lines indicate permissible but marginal dates.)	Remarks
BARLEY (Hordeum vulgare)			M-L 4/ P C		
alone	3 bu. (144 lbs.)	3.3 lb			14,000 seed per pound. Winterhardy. Use on productive soils.
in mixtures	1/2 bu. (24 lbs.)	0.6 lb.			
LESPEDEZA, ANNUAL (Lespedeza striata)			M-L P C		
alone	40 lbs.	0.9 lb.			200,000 seed per pound. May volunteer for several years. Use inoculant EL.
in mixtures	10 lbs.	0.2 lb.			
LOVEGRASS, WEEPING (Eragrostis curvula)			M-L P C		
alone	4 lbs.	0.1 lb.			1,500,000 seed per pound. May last for several years. Mix with Sericea lespedeza.
in mixtures	2 lbs.	0.05 lb.			
MILLET, BROWNTOP (Panicum fasciculatum)			M-L P C		
alone	40 lbs.	0.9 lb.			137,000 seed per pound. Quick dense cover. Will provide too much competition in mixtures if seeded at high rates.
in mixtures	10 lbs.	0.2 lb.			

PLANTS, PLANTING RATES, AND PLANTING DATES FOR TEMPORARY COVER OR COMPANION CROPS 1/

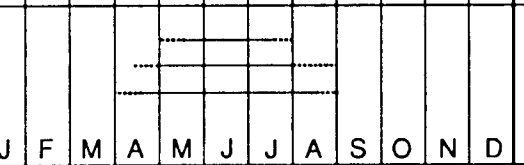
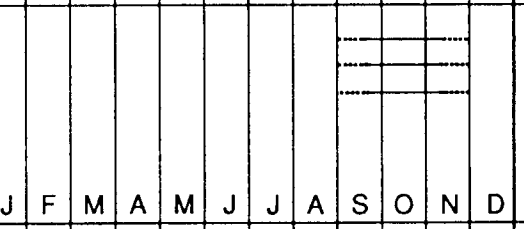
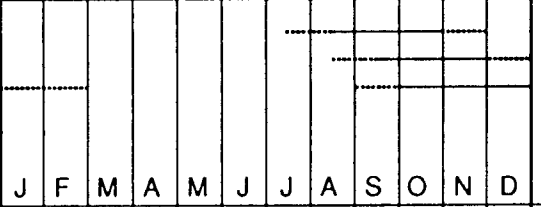
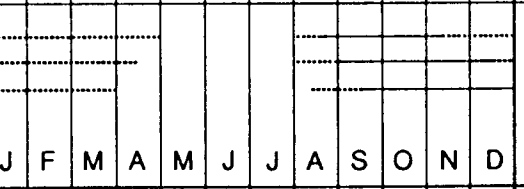
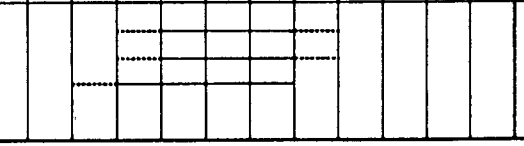
Species	Broadcast Rates 2/ - PLS 3/ Per Acre	Broadcast Rates 2/ - PLS 3/ Per 1000 sq. ft.	Resource Area	Planting Dates by Resource Areas Planting Dates (Solid lines indicate optimum dates, dotted lines indicate permissible but marginal dates.)	Remarks
MILLET, PEARL (Pennesetum glaucum) alone	50 lbs.	1.1 lb	M-L P C		88,000 seed per pound. Quick dense cover. May reach 5 feet in height. Not recommended for mixtures.
OATS (Avena sativa) alone	4 bu. (128 lbs.)	2.9 lb.	M-L P C		13,000 seed per pound. Use on productive soils. Not as winterhardy as rye or barley.
in mixtures	1 bu. (32 lbs.)	0.7 lb.			
RYE (Secale cereale) alone	3 bu. (168 lbs.)	3.9 lb.	M-L P C		18,000 seed per pound. Quick cover. Drought tolerant and winterhardy.
in mixtures	1/2 bu. (28 lbs.)	0.6 lb.			
RYEGRASS, ANNUAL (Lolium temulentum) alone	40 lbs.	0.9 lb.	M-L P C		227,000 seed per pound. Dense cover. Very competitive and is not to be used in mixtures.
SUDANGRASS (Sorghum sudanese) alone	60 lbs.	1.4 lb	M-L P C		55,000 seed per pound. Good on droughty sites. Not recommended for mixtures.

Table 6-24.1 continued

PLANTS, PLANTING RATES, AND PLANTING DATES FOR TEMPORARY COVER OR COMPANION CROPS 1/

Species	Broadcast Rates 2/ - PLS 3/ Per Acre	Broadcast Rates 2/ - PLS 3/ Per 1000 sq. ft.	Resource Area	Planting Dates by Resource Areas — Planting Dates (Solid lines indicate optimum dates, dotted lines indicate permissible but marginal dates.) J F M A M J J A S O N D	Remarks
TRITICALE (X-Triticosecale)			C	..... ---- ---- ----	
alone	3 bu. (144 lbs.)	3.3 lb.			Use on lower part of Southern Coastal Plain and In Atlantic Coastal Flatwoods only.
in mixtures	1/2 bu. (24 lbs.)	0.6 lb.			
				J F M A M J J A S O N D	
WHEAT (Triticum aestivum)			M-L P C	---- ---- ---- ----	
alone	3 bu. (180 lbs.)	4.1 lb.		..... ---- ---- ----	15,000 seed per pound. Winterhardy.
in mixtures	1/2 bu. (30 lbs.)	0.7 lb.			

1/ Temporary cover crops are very competitive and will crowd out perennials if seeded too heavily.
2/ Reduce seeding rates by 50% when drilled.
3/ PLS is an abbreviation for Pure Live Seed.
4/ M-L represents the Mountain; Blue Ridge; and Ridges and Valleys MLRAs
P represents the Southern Piedmont MLRA
C represents Southern Coastal Plain; Sand Hills; Black Lands; and Atlantic Coast Flatwoods MLRAs

Disturbed Area Stabilization (With Permanent Vegetation)

Ds3

DEFINITION

Planting vegetation, such as trees, shrubs, vines, grasses, or legumes, on highly erodible or critically eroding areas (does not include tree planting mainly for wood products).

PURPOSE

To stabilize the soil, reduce damage from sediment and runoff to downstream areas, and improve wildlife habitat and visual resources.

CONDITIONS

On highly erodible or critically eroding areas. These areas usually cannot be stabilized by ordinary conservation treatment and management and if left untreated can cause severe erosion or sediment damage. Examples of applicable areas are dams, dikes, levees, cuts, fills, and denuded or gullied areas where vegetation is difficult to establish by usual planting methods.

PLANNING CONSIDERATIONS

1. Use conventional planting methods where possible.
2. Companion crops aid in getting permanent cover established, especially when mixed plantings are done during marginal planting periods.
3. No-till planting is effective when planting is done following a summer or winter annual cover crop. Sericea lespedeza planted no-till into stands of rye is an excellent procedure.
4. Block sod is effective in controlling erosion adjacent to concrete flumes and other structures.
5. Consider using irrigation, especially when late plantings are done.
6. Use low maintenance plants in most cases to ensure long-lasting erosion control.
7. Mowing should not be performed during the quail nesting season, (September to April).
8. Wildlife plantings should be included in critical area plantings.

Commercially available plants include the following:	Remarks
Type of Plant	
A. Mast Bearing Trees: Beech, Black Cherry, Blackgum, Chestnut, Chinkapin, Hackberry, Hickory, Honey Locust, Native Oak, Persimmon, Pine, Sawtooth Oak and Sweetgum.	All trees that produce nuts or fruits are favored by many game species, except hickory which provides nuts used mainly by squirrels and bear.
B. Shrubs and Small Trees: Autumn Olive, Bayberry, Bicolor Lespedeza, Crabapple, Dogwood, Huckleberry or Native Blueberry, Mountain Laurel, Native Holly, Red Cedar, Red Mulberry, Russion Olive, Privet, Sumac, Wax Myrtle, Wild Plum and Blackberry.	Plant in patches without tall trees to develop stable shrub communities. All produce fruits used by many kinds of wildlife, except for lespedeza which produces seeds used by quail and songbirds.
C. Grasses, Legumes, Vines and Temporary Cover: Bahiagrass, Bermudagrass, Grape, Grass-Legume mixtures, Partridge Pea, Annual Lespedeza, Honeysuckle, Orchardgrass (for mountains) and temporary cover (such as Browntop Millet).	For openings. Provides herbaceous cover in clearings for a game bird, brood-rearing habitat. Appropriate legumes such as vetches, clovers, and lespedezas may be mixed with grass, but they may die out after a few years.

SPECIFICATIONS

Grading and Shaping

A. Grading and shaping is not normally required where hydraulic seeding and fertilizing equipment is to be used. Vertical banks shall be sloped to enable plant establishments.

B. When conventional seeding and fertilizing is to be done, grade and shape where feasible and practical, so that equipment can be used safely and efficiently during seedbed preparation, seeding, mulching and maintenance of the vegetation.

C. Concentrations of water that will cause excessive soil erosion will be diverted to a safe outlet. Diversions and other treatment practices must conform with the appropriate standards and specifications.

Seedbed Preparation

A. Seedbed preparation is not required where hydraulic seeding and fertilizing equipment is to be used.

B. When conventional seeding is to be used, seedbed preparation will be done as follows:

1. Broadcast plantings.
   a. Tillage at a minimum, shall adequately loosen the soil to a depth of 4 to 6 inches; alleviate compaction; incorporate lime and fertilizer; smooth and firm the soil; allow for the proper placement of seed, sprigs, or plants; and allow for the anchoring of straw or hay mulch if a disk is to be used.
   b. Tillage may be done with any suitable equipment.
   c. Tillage may be done on the contour where feasible.
   d. On slopes too steep for the safe operation of tillage equipment, the soil surface will be pitted or trenched across the slope with appropriate hand tools to provide a place 6 to 8 inches apart in which seed may lodge and germinate.
2. Individual plants.
   a. Where individual plants are to be set, the soil will be well prepared by excavating holes, opening furrows, or dibble planting.
   b. For nursery stock plants, holes shall be large enough to accommodate roots without crowding.
   c. Where pine seedlings are to be planted, subsoil under the row 36 inches deep on

the contour 4 to 6 months prior to planting. Subsoiling should be done when the soil is dry, preferably in August or September.

Lime and Fertilizer—Rates and Analysis

A. Where permanent vegetation is to be established, agricultural lime shall be applied as indicated by soil test or at the rate of 1 to 2 tons per acre. Agricultural lime shall be within the specifications of the Georgia Department of Agriculture.

Lime spread by conventional equipment will be "ground limestone." Ground limestone is calcitic or dolomitic limestone ground so that 90 percent of the material will pass through a 10-mesh sieve, not less than 50 percent will pass through a 50-mesh sieve and not less than 25 percent will pass through a 100-mesh sieve.

Agricultural lime spread by hydraulic seeding equipment will be "finely ground limestone." Finely ground limestone is calcitic or dolomitic limestone ground so that 98 percent of the material will pass through a 20-mesh sieve and not less than 70 percent will pass through a 100-mesh sieve.

It is desirable to use dolomitic limestone in the Sand Hills, Southern Coastal Plain and Atlantic Coast Flatwoods MLRAs.

B. No agricultural lime is required where only temporary seeding is to be done or where only trees are planted.

C. Initial fertilization requirements for each species or combination of species are listed in Table 6-25.1

Lime Fertilizer—Application

A. When hydraulic seeding equipment is used:
   1. The initial fertilizer will be mixed with seed, inoculant (if needed) and wood cellulose or wood pulp fiber mulch and applied in a slurry. The slurry mixture will be agitated during application to keep the ingredients thoroughly mixed. The mixture will be spread uniformly over the area within one hour after being placed in the hydroseeder.
   2. Finely ground limestone will be mixed with water and applied immediately after mulching is completed or in combination with the top dressing.

B. When conventional planting is to be done, lime and fertilizer will be applied uniformly in one of the following ways:
   1. Apply before land preparation so that it will be mixed with the soil during seedbed preparation; or,
   2. Mix with the soil used to fill the holes, distribute in furrows; or
   3. Broadcast after steep surfaces are scarified, pitted or trenched.
   4. A fertilizer pellet will be placed at root depth beside each pine tree seedling.

Plant Selection

A. Refer to Tables 6-24.1, 6-25.2, 6-25.3 and 6-25.4 for approved species.

B. Species not listed shall be approved by the State Resource Conservationist of the Soil Conservation Service before they are used.

C. Plants shall be selected on the basis of species characteristics; site and soil conditions; planned use and maintenance of the area; time of year of planting; method of planting; and the needs and desires of the land user.

D. Plant selections may include companion crops to provide quick cover. Care shall be taken in selecting companion crop species and seeding rates to limit competition so that the desired permanent vegetation may become established as soon as possible.

E. The term "pure live seed" is used to express the quality of seed, even if it is not shown on the label. Pure live seed, PLS, is expressed as a percentage of the seeds that are pure and will germinate. PLS is determined by multiplying the percent of pure seed times the percent of germination and dividing by 100.

EXAMPLE:

Common bermuda seed
70% germination
80% purity

$$PLS = \frac{70\% \text{ germination} \times 80\% \text{ purity}}{100}$$

$$PLS = \frac{56}{100} = 0.56 = 56\%$$

The percent of PLS helps you determine the amount of seed you need. If the seeding rate is 10 pounds PLS and the bulk seed is 56 percent PLS, the bulk seeding rate is:

$$\frac{10 \text{ lbs. PLS/acre}}{56\% \text{ PLS}} = 17.9 \text{ lbs/acre}$$

You would need to plant 17.9 lbs/acre to provide 10 lbs/acre of pure live seed.

Inoculants

A. All legume seed shall be inoculated with appropriate nitrogen-fixing bacteria.
B. The inoculant shall be a pure culture prepared specifically for the seed species and used within the dates on the container.
C. A mixing medium recommended by the manufacturer shall be used to bond the inoculant to the seed.
D. For conventional seeding, two times the amount of inoculant recommended by the manufacturer shall be used.
E. For hydraulic seeding, four times the amount of inoculant recommended by the manufacturer shall be used.
F. All inoculated seed shall be protected from the sun and high temperatures and shall be planted the same day inoculated. No inoculated seed shall remain in the hydroseeder longer than one hour.

Planting

A. Hydraulic seeding - Mix the seed, inoculant, fertilizer, and wood cellulose or wood pulp fiber mulch with water and apply in a slurry uniformly over the area to be treated. Apply within one hour after the mixture is made.
B. Conventional seeding - Seeding will be done on a freshly prepared and firmed seedbed. For broadcast planting, use a cultipacker-seeder, drill, rotary seeder, other mechanical seeder, or hand seeding to distribute the seed uniformly over the area to be treated. Cover the seed lightly with a cultipacker or other suitable equipment.
C. No-till seeding is permissible into annual cover crops when planting is done following maturity of the cover crop or if the temporary cover stand is sparse enough to allow adequate growth of the permanent species. No-till seeding must be done with appropriate no-till seeding equipment. The seed must be uniformly distributed and planted at the proper depth.
D. Individual plants - Shrubs, vines and sprigs may be planted with appropriate planters or hand tools. Pine trees will be planted manually in the subsoil furrow. Each plant will be set in a manner that will avoid crowding the roots.

   Nursery stock plants shall be planted at the same depth or slightly deeper than they grew at the nursery. The tips of vines and sprigs must be at or slightly above the ground surface.

   Where individual holes are dug, place fertilizer in the bottom of the hole, add two inches of soil and set the plant.

Mulching

Use mulch on all slopes steeper than 3 percent; when seedings are made so late in the fall and winter that germination cannot be expected until spring; in the bottom of spillways; and on roadbanks.

Temporary vegetation seeded alone may be established on good sites without the use of mulch.

Mulching material will consist of:

A. Use dry straw or dry hay of good quality and free of weed seeds. Dry straw will be applied at the rate of 2 tons per acre. Dry hay will be used at a rate of 2 1/2 tons per acre; or,
B. For hydraulic seeding, use wood cellulose mulch or wood pulp fiber at the rate of 500 pounds per acre and dry straw or dry hay at the rate listed in A, above; or,
C. For hydraulic seeding on slopes 3/4:1 or steeper, 1,000 pounds of wood cellulose or wood pulp fiber which includes a tackifier may be substituted for the treatment in B, above; or,
D. Use three tons per acre of Sericea lespedeza hay containing mature seed; or,
E. Apply pine straw or pine bark at a thickness of 3 inches. Other suitable materials in sufficient quantity may be used where ornamentals or other ground covers are planted; or,
F. Soil retention blankets, erosion control netting, other manufactured materials, or block sod may be required in addition to mulch on unstable soils and concentrated flow areas.

Wood cellulose and wood pulp fibers shall not contain germination or growth inhibiting factors. They will have the property to be evenly dispersed when agitated in water. The fibers shall have a contrasting color to the soil to allow visual metering and aid in uniform application during seeding.

Applying Mulch

A. Straw or hay mulch will be spread uniformly within 24 hours after seeding and/or planting. The mulch may be spread by blower-type spreading equipment, other spreading equipment or by hand. About 75 percent of the soil surface will be covered.
B. Wood cellulose or wood fiber mulch will be applied with hydraulic seeding equipment.

Anchoring Mulch

A. Anchor straw or hay mulch immediately after application by one of the following methods:
   1. By emulsified asphalt, (a) sprayed uniformly onto the mulch as it is ejected from the blower

onto the mulch as it is ejected from the blower machine, or (b) sprayed on the mulch immediately following mulch application when straw or hay is spread by methods other than special blower equipment.

The combination of asphalt emulsion and water shall consist of a homogeneous mixture satisfactory for spraying. The mixture shall consist of 100 gallons of grade SS-1h or CSS-1h emulsified asphalt and 100 gallons of water per ton of mulch.

Care shall be taken at all times to protect the public, adjacent property, pavements, curbs, sidewalks, and all other structures from asphalt discoloration.

2. Press the mulch into the soil immediately after the mulch is spread. A special "packer disk" or disk harrow with the disks set straight may be used. The disks may be smooth or serrated and should be 20 inches or more in diameter and 8 to 12 inches apart. The edges of the disks shall be dull enough to press the mulch into the ground without cutting it, leaving much of it in an erect position.
3. Apply synthetic tackifiers or binders applied immediately after the mulch is spread. Synthetic tackifiers will be mixed and applied according to manufacturer's specifications.
4. Fall and winter plantings may include 1/2 bushel of rye or wheat to stabilize the mulch.
5. Plastic mesh or netting with no larger than one inch by one inch mesh may be needed to anchor straw or hay mulch on unstable soils and concentrated flow areas.

B. Where wood cellulose or wood pulp fiber mulch is applied alone, a tackifier will be used.

Irrigation

Irrigation will be applied at a rate that will not cause runoff.

Topdressing

Topdressing will be applied on all temporary grass species and permanent grasses planted alone or in mixtures with other species. Recommended rates of application are listed in Table 6-25.1.

Second Year and Maintenance Fertilization

Second year fertilizer rates and maintenance fertilizer rates are listed in Table 6-25.1.

Lime and Maintenance Application

Apply one ton of agricultural lime every 4 to 6 years or as indicated by soil tests.

Use and Management

Mow Sericea lespedeza only after frost to ensure that the seeds are mature. Mow between November and March.

Bermudagrass, Bahiagrass and Tall fescue may be mowed as desired. Maintain at least 6 inches of top growth under any use and management. Moderate use of top growth is beneficial after establishment.

Exclude livestock until the plants are well established.

Table 6-25.1

FERTILIZER REQUIREMENTS

TYPE OF SPECIES	YEAR	ANALYSIS OR EQUIVALENT N-P-K	RATE	N TOP DRESSING RATE
1. Cool season grasses	First	6-12-12	1500 lbs./ac.	50-100 lbs./ac. 1/ 2/
	Second	6-12-12	1000 lbs./ac.	—
	Maintenance	10-10-10	400 lbs./ac.	30
2. Cool season grasses and legumes	First	6-12-12	1500 lbs./ac.	0-50 lbs./ac. 1/
	Second	0-10-10	1000 lbs./ac.	—
	Maintenance	0-10-10	400 lbs./ac.	—
3. Ground covers	First	10-10-10	1300 lbs./ac. 3/	—
	Second	10-10-10	1300 lbs./ac. 3/	—
	Maintenance	10-10-10	1100 lbs./ac.	—
4. Pine seedlings	First	20-10-5	one 21-gram pellet per seedling placed in the closing hole	—
5. Shrub Lespedeza	First	0-10-10	700 lbs./ac.	—
	Maintenance	0-10-10	700 lbs./ac. 4/	
6. Temporary cover crops seeded alone	First	10-10-10	500 lbs./ac.	30 lbs./ac. 5/
7. Warm season grasses	First	6-12-12	1500 lbs./ac.	50-100 lbs./ac. 2/ 6/
	Second	6-12-12	800 lbs./ac.	50-100 lbs./ac. 2/
	Maintenance	10-10-10	400 lbs./ac.	30 lbs./ac.
8. Warm season grasses and legumes	First	6-12-12	1500 lbs./ac.	50 lbs./ac. 6/
	Second	0-10-10	1000 lbs./ac.	
	Maintenance	0-10-10	400 lbs./ac.	

1/ Apply in spring following seeding.
2/ Apply in split applications when high rates are used.
3/ Apply in 3 split applications.
4/ Apply when plants are pruned.
5/ Apply to grass species only.
6/ Apply when plants grow to a height of 2 to 4 inches.

Table 6-25.2

PLANTS, PLANTING RATES, AND PLANTING DATES FOR PERMANENT COVER

Species	Broadcast Rates 2/ - PLS 3/ Per Acre	Broadcast Rates 2/ - PLS 3/ Per 1000 sq. ft.	Resource Area	Planting Dates by Resource Areas (Solid lines indicate optimum dates, dotted lines indicate permissible but marginal dates.) J F M A M J J A S O N D	Remarks
BAHIA, PENSACOLA (Paspalum notatum)			P 3/ C		166,000 seed per pound. Low growing. Sod forming. Slow to establish. Plant with a companion crop. Will spread into bermuda pastures and lawns. Mix with Sericea lespedeza or weeping lovegrass.
alone or with temporary cover	60 lbs.	1.4 lb.			
with other perennials	30 lbs.	0.7 lb.			
BAHIA, WILMINGTON (Paspalum notatum)			M-L P		Same as above.
alone or with temporary cover	60 lbs.	1.4 lb.			
with other perennials	30 lbs.	0.7 lb.			
BERMUDA, COMMON (Cynodon dactylon) Hulled seed			P C		1,787,000 seed per pound. Quick cover. Low growing and sod forming. Full sun. Good for athletic fields.
alone	10 lbs.	0.2 lb.			
with other perennials	6 lbs.	0.1 lb.			

Table 6-25.2 continued

PLANTS, PLANTING RATES, AND PLANTING DATES FOR PERMANENT COVER

Species	Broadcast Rates 2/ - PLS 3/ Per Acre	Broadcast Rates 2/ - PLS 3/ Per 1000 sq. ft.	Resource Area	Planting Dates by Resource Areas — Planting Dates (Solid lines indicate optimum dates, dotted lines indicate permissible but marginal dates.) J F M A M J J A S O N D	Remarks
BERMUDA, COMMON (Cynodon dactylon) Unhulled seed			P C		
with temporary cover	10 lbs.	0.2 lb.			Plant with winter annuals.
with other perennials	6 lbs.	0.1 lb.			Plant with Tall fescue.
BERMUDA SPRIGS (Cynodon dactylon)	40 cu. ft. or sod plugs 3' x 3'	0.9 cu. ft.	M-L		A cubic foot contains approximately 650 sprigs. A bushel contains 1.25 cubic feet or approximately 800 sprigs.
Coastal, Common, Midland, or Tift 44					
Coastal, Common, or Tift 44			P C		Same as above
Tift 78			C		Southern Coastal Plain only.
CENTIPEDE (Eremochloa ophiuroides)	Block sod only		P C		Drought tolerant. Full sun or partial shade. Effective adjacent to concrete and in concentrated flow areas. Irrigation is needed until fully established. Do not plant near pastures. Winterhardy as far north as Athens and Atlanta.

Table 6-25.2 continued

PLANTS, PLANTING RATES, AND PLANTING DATES FOR PERMANENT COVER

Species	Broadcast Rates 2/ - PLS 3/ Per Acre	Broadcast Rates 2/ - PLS 3/ Per 1000 sq. ft.	Resource Area	Planting Dates by Resource Areas Planting Dates (Solid lines indicate optimum dates, dotted lines indicate permissible but marginal dates.) J F M A M J J A S O N D	Remarks
CROWNVETECH (Coronilla varia) with winter annuals or cool season grasses	15 lbs.	0.3 lb.	M-L P	J F M A M J J A S O N D	100,000 seed per pound. Dense growth. Drought tolerant and fire resistant. Attractive rose, pink, and white blossoms spring to late fall. Mix with 30 pounds of Tall fescue or 15 pounds of rye. Inoculate seed with M inoculant. Use from North Atlanta and Northward
FESCUE, TALL (Festuca arundinacea) alone	50 lbs.	1.1 lb.	M-L P	J F M A M J J A S O N D	227,000 seed per pound. Use alone only on better sites. Not for droughty soils. Mix with perennial lespedezas or Crownvetch. Apply topdressing in spring following fall plantings. Not for heavy use areas or athletic fields.
with other perennials	30 lbs.	0.7 lb.			
KUDZU (Pueraria thumbergiana) plants or crowns	3' - 7' apart		ALL		Rapid and vigorous growth. Excellent in gully erosion control. Will climb. Good livestock forage.

Table 6-25.2 continued

PLANTS, PLANTING RATES, AND PLANTING DATES FOR PERMANENT COVER

Species	Broadcast Rates 2/ - PLS 3/ Per Acre	Broadcast Rates 2/ - PLS 3/ Per 1000 sq. ft.	Resource Area	Planting Dates by Resource Areas — Planting Dates (Solid lines indicate optimum dates, dotted lines indicate permissible but marginal dates.) J F M A M J J A S O N D	Remarks
LESPEDEZA Ambro virgata (Lespedeza virgata DC) or Appalow (Lespedeza cuneata [Dumont] G. Don)					300,000 seed per pound. Height of growth is 18 to 24 inches. Advantageous in urban areas. Spreading-type growth. New growth has bronze coloration. Mix with weeping lovegrass, common bermuda, bahia, tall fescue or winter annuals. Do not mix with Sericea lespedeza. Slow to develop solid stands. Inoculate seed with EL inoculant.
scarified	60 lbs.	1.4 lb.	M-L P C		
unscarified	75 lbs.	1.7 lb.	M-L P C		
LESPEDEZA, SHRUB (Lespedeza bicolor)) (Lespedeza thumbergii) plants	3' X 3'		M-L P C		Provide wildlife food and cover.
LOVEGRASS, WEEPING (Eragrostis curvula)					1,500,000 seed per pound. Quick cover. Drought tolerant. Grows well with Sericea lespedeza on roadbanks.
alone	4 lbs.	0.1 lb.	M-L P C		
with other perennials	2 lbs.	0.05 lb.			

Table 6-25.2 continued

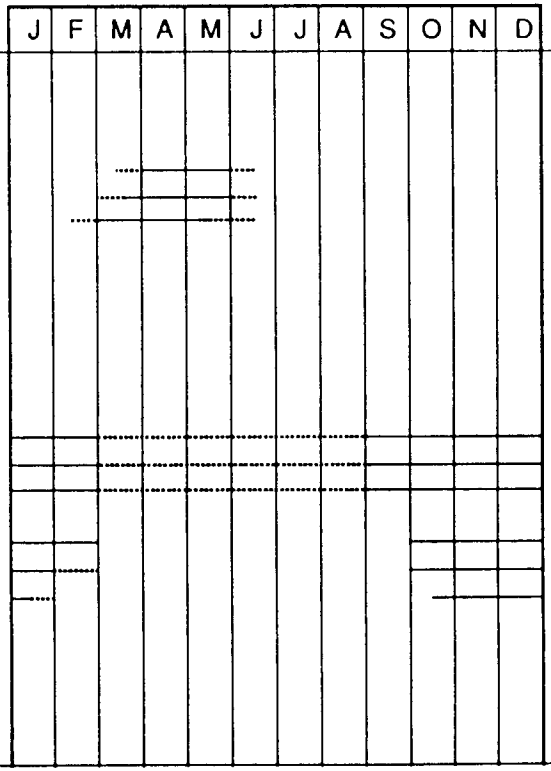
PLANTS, PLANTING RATES, AND PLANTING DATES FOR PERMANENT COVER

Species	Broadcast Rates 2/ - PLS 3/ Per Acre	Broadcast Rates 2/ - PLS 3/ Per 1000 sq. ft.	Resource Area	Planting Dates by Resource Areas Planting Dates (Solid lines indicate optimum dates, dotted lines indicate permissible but marginal dates.) J F M A M J J A S O N D	Remarks
MAIDENCANE (Panicum hemitomon)					For very wet sites. May clog channels. Dig sprigs from local sources. Use along river banks and shorelines.
sprigs	2' x 3' spacing		ALL		
PANICGRASS, ATLANTIC COASTAL (Panicum amarum var. amarulum))	20 lbs.	0.5 lb.	P C	J F M A M J J A S O N D	Grows well on coastal sand dunes, borrow areas, and gravel pits. Provides winter cover for wildlife. Mix with Sericea lespedeza except on sand dunes.
REED CANARY GRASS (Phalaris arundinacea)					Grows similar to Tall fescue.
alone	50 lbs.	1.1 lb.	M-L P		
with other perennials	30 lbs.	0.7 lb.		J F M A M J J A S O N D	
SUNFLOWER, 'AZTEC' MAXIMILLIAN (Helianthus maximiliani)	10 lbs.	0.2 lb.	M-L P C	J F M A M J J A S O N D	227,000 seed per pound. Mix with Weeping lovegrass or other low-growing grasses or legumes.
SWITCHGRASS (Panicum virgatum)	40 lbs.	0.9 lb	M-L P C		Streambanks

1/ Reduce seeding rates by 50% when drilled.
2/ PLS is an abbreviation for Pure Live Seed. Refer to Section V.E. of these specifications.
3/ M-L represents to Mountain; Blue Ridge; and Ridges and Valleys MLRAs.
P represents the Southern Piedmont MLRA.
C represents the Southern Coastal Plain; Sand Hills; Black Lands; and Atlantic Coast Flatwoods MLRAs.

Table 6-25.2 continued

PLANTS, PLANTING RATES, AND PLANTING DATES FOR PERMANENT COVER

Species	Broadcast Rates 2/ - PLS 3/ Per Acre	Broadcast Rates 2/ - PLS 3/ Per 1000 sq. ft.	Resource Area	Planting Dates by Resource Areas — Planting Dates (Solid lines indicate optimum dates, dotted lines indicate permissible but marginal dates.)	Remarks
LESPEDEZA, SERICEA (Lespedeza cuneata)					
scarified	60 lbs.	1.4 lb.	M-L P C		350,000 seed per pound. Widely adapted. Low maintenance. Mix with Weeping lovegrass, Common bermuda, bahia, or tall fescue. Takes 2 to 3 years to become fully established. Excellent on roadbanks. Inoculate seed with EL inoculant.
unscarified	75 lbs.	1.7 lb.	M-L P C		Mix with Tall fescue or winter annuals.
seed-bearing hay	3 tons	138 lb.	M-L P C		Cut when seed is mature, but before it shatters. Add Tall fescue or winter annuals.

J F M A M J J A S O N D

DURABLE SHRUBS AND GROUND COVERS FOR PERMANENT COVER

Ground covers include a wide range of low-growing plants planted together in considerable numbers to cover large areas of the landscape. Ground covers grow slower than grasses. Weeds are likely to compete, especially the first year. Maintenance is needed to insure survival. These ground covers will not be used unless proper maintenance is planned. Maintain mulch at three-inch thickness until plants provide adequate cover.

Fall planting is encouraged because the need for constant watering is reduced and plants have time to establish new roots before hot weather.

Common Name	Scientific Name	Mature Height	Plant Spacing	Comments
Albelia	Abelia grandiflora	3-4 ft.	5 ft.	Also a prostrate form 2 feet high. Sun, semi-shade. Semi-evergreen.
Carolina Yellow Jessamine	Gelsemium sempervirens	low	3 ft.	Vine. Yellow, trumpet-like flowers. Hardy, one of best vines. Evergreen. Native to Georgia.
Carpet Blue	Ajuga reptans	2-4 in.	3 ft.	Needs good drainage, partial shade. Blue or white flowers. Evergreen.
Bearberry Cotoneaster	Cotoneaster dammeri	2-4 ft.	5 ft.	White flowers, red fruit. Sun. Evergreen.
Ground Cover Cotoneaster	Cotoneaster salicifoluis 'Repens'	1-2 ft.	5 ft.	White flowers, red fruit. Sun. Evergreen.
Rock Cotoneaster	Cotoneaster horizontalis	1-2 ft.	5 ft.	Semi-evergreen. Sun.
Virginia Creeper	Parthenocissue quinquefolia	low	3 ft.	Red in fall. Vine. Deciduous. Native to Georgia.
Daylily	Hemerocallis spp.	2-3 ft.	2 ft.	Many flower colors. Full sun. Very hardy.
Elaegnus	Elaegnus pungens	8-10 ft.	6 ft.	Fast grower. Sun, semi-shade.
English Ivy	Hedera helix	low	3 ft.	Shade only. Climbs.

DURABLE SHRUBS AND GROUND COVERS FOR PERMANENT COVER

Common Name	Scientific Name	Mature Height	Plant Spacing	Comments
Wintercreeper Euonymus	Euonymus fortunii 'Coloratus'	18 in.	4 ft.	Orange fruit in fall, will climb. Evergreen. Sun or semi-shade. Good on banks.
Everblooming Honeysuckle	Lonecera heckrottii	low	3 ft.	Coral-red flowers in summer. Semi-evergreen. Climbs.
Compacta Holly	Ilex crenata 'Compacta'	3-4 ft.	5 ft.	Sun, semi-shade.
Chinese Holly	Ilex cornuta 'Rotunda'	3-4 ft.	5 ft.	Very durable. Sun, semi-shade.
Dwarf Burford Holly	Ilex burfordii 'Nana'	5-8 ft.	8 ft.	
Dwarf Yaupon Holly	Ilex vomitoria 'Nana'	3-4 ft.	5 ft.	Very durable. sun, semi-shade.
Repandens Holly	Ilex crenata 'Repandens'	2-3 ft.	5 ft.	Sun, semi-shade.
Andorra Juniper	Juniperus horizontalis 'Plumosa'	2-3 ft.	5 ft.	Excellent for slopes. Sun.
Andorra Compacta	Juniperus horizontalis 'Plumosa compacta'	1-2 ft.	5 ft.	More compact than andora.
Blue Chip Juniper	Juniperus horizontalis 'Blue Chip'	8-10 in.	4 ft.	
Blue Rug Juniper	Juniperus horizontalis 'Wiltonii'	4-6 in.	3 ft.	Very low. Sun.
Parsons Juniper	Juniperus davurica 'Expansa' (Squamata Parsoni)	18-24 in.	5 ft.	One of the best, good winter cover.
Pfitzer Juniper	Juniperus chinensis 'Pfitzerana'	6-8 ft.	6 ft.	Needs room.

DURABLE SHRUBS AND GROUND COVERS FOR PERMANENT COVER

Common Name	Scientific Name	Mature Height	Plant Spacing	Comments
Prince of Wales Juniper	Juniperus horizontalis 'Prince of Wales'	8-10 in.	4 ft.	Feathery appearance.
Sargent Juniper	Juniperus chinensis 'Sargentii'	1-2 ft.	5 ft.	Full sun. Needs good drainage. Good winter color.
Shore Juniper	Juniperus conferta	2-3 ft.	5 ft.	Emerald Sea or Blue Pacific cultivars are good.
Liriope	Liriope muscari	8-10 in.	3 ft.	
Creeping Liriope	Liriope spicata	10-12 in.	1 ft.	Spreads by runners.
Big Leaf Periwinkle	Vinca major	12-15 in.	4 ft.	Lilac flowers in spring. Semi-shade.
Common Periwinkle	Vinca minor	5-6 int.	4 ft.	Lavender-blue flowers in spring. Semi-shade
Cherokee Rose	Rosa laevigata	2 ft.	5 ft.	Rampant grower. Not for restricted spaces. State flower.
Memoria Rose	Rosa weuchuriana	2 ft.	5 ft.	Rampant grower.
St. Johnswort	Hypericum calycenum	8-12 in.	3 ft.	Semi-shade.
Anthony Waterer Spirea	Spirea bumalda	3-4 ft.	5 ft.	Sun.
Thunberg Spirea	Spirea thinbergii	3-4 ft.	5 ft.	Sun.
Chinese Wisteria	Wisteria sinensis	10 ft. tree or trailing	6 ft.	Rapid growth.

Table 6-25.4

TREES FOR EROSION CONTROL

SITE	SOIL MATERIAL	COMMON SOILS	PLANTING TREE SPECIES 1/	SPACING	PLANTING DATES 3/
Borrow areas, graded areas, and spoil material	Sandy	Lakeland, Troup	Loblolly pine (Pinus taeda) Longleaf pine (Pinus palustris) Slash pine (Pinus elliottii)	2/	M-L,P 12/1-3/15 C 12/1-3/1
	Loamy	Orangeburg, Tifton	Loblolly pine Slash pine	2/	M-L,P 12/1-3/15 C 12/1-3/1
	Clay	Cecil, Faceville	Loblolly pine Slash pine Virginia pine (Pinus virginiana)	2/	M-L,P 12/1-3/15 C 12/1-3/1
Streambanks			Willows 4/ (Salix species)	2 ft x 2 ft	ALL 2/15-3/15

1/ Other trees and shrubs listed on Table 6-25.3 may be interplanted with the pines for improved wildlife benefits.

2/ Type of Planting	Tree Spacing	No. of Trees Per Acre
Trees alone	4 ft. x 4 ft.	2722
Trees in combination with grasses and/ or other plants	6 ft. x 6 ft.	1210

3/ M-L represents the Mountains; Blue Ridge; and Ridges and Valleys MLRAs
P represents the Southern Piedmont MLRA
C represents the Southern Coastal Plain; Sand Hills; Black Lands; and Atlantic Coast Flatwoods MLRAs

4/ Fertilization of companion crop is ample for this species.

Dust Control on Disturbed Areas

Du

DEFINITION

Controlling surface and air movement of dust on construction sites, roads, and demolition sites.

PURPOSE

To prevent surface and air movement of dust from exposed soil surfaces and reduce the presence of airborne substances which may be harmful or injurious to human health, welfare, or safety, or to animals or plant life.

CONDITIONS

This practice is applicable to areas subject to surface and air movement of dust where on and off-site damage may occur without treatment.

METHOD AND MATERIALS

A. TEMPORARY METHODS

Mulches. See standard *Ds1 - Disturbed Area Stabilization (With Mulches Only).* Synthetic resins may be used instead of asphalt to bind mulch material. Resins such as Curasol or Terratack should be used according to manufacturer's recommendations.

Vegetative Cover. See standard *Ds2- Disturbed Area Stabilization (With Temporary Seeding).*

Spray-on Adhesives. These are used on mineral soils (not effective on muck soils). Keep traffic off these areas.

Tillage. This practice is designed to roughen and bring clods to the surface. It is an emergency measure which should be used before wind erosion starts. Begin plowing on windward side of site. Chisel-type plows spaced about 12 inches apart, spring-toothed harrows, and similar plows are examples of equipment which may produce the desired effect.

Irrigation. This is generally done as an emergency treatment. Site is sprinkled with water until the surface is wet. Repeat as needed.

Barriers. Solid board fences, snowfences, burlap fences, crate walls, bales of hay and similar material can be used to control air currents and soil blowing. Barriers placed at right angles to prevailing currents at intervals of about 15 times their height are effective in controlling wind erosion.

Calcium Chloride. Apply at rate that will keep surface moist. May need retreatment.

B. PERMANENT METHODS

Permanent Vegetation. See standard *Ds3 - Disturbed Area Stabilization (With Permanent Vegetation).* Existing trees and large shrubs may afford valuable protection if left in place.

Topsoiling. This entails covering the surface with less erosive soil material. See standard *Tp - Topsoiling.*

Stone. Cover surface with crushed stone or coarse gravel.

Table 6-26.1

Adhesive	Water Dilution	Type of Nozzle	Application Rate (Gallons/Ac.)
Anionic Asphalt emulsion	7:1	Coarse Spray	1,200
Latex emulsion	12½:1	Fine Spray	235
Resin-in-water emulsion	4:1	Fine Spray	300

APPENDIX C
FORMS

SCS EROSION AND SEDIMENT CONTROL PLAN REVIEW CHECKLIST

Project Name_____
Project Review Number_____

'te Plan:
) Graphic scale and north arrow.
) Vicinity map - small map showing site relative to surrounding area, including designation of specific phase, if necessary.
3) Existing and planned contours, shown to a maximum contour interval of 5 feet.
4) Adjacent areas - neighboring areas, such as streams, lakes, residential areas, etc., which might be affected, should be shown on plan.
5) Location of erosion and sediment control practices, preferably using uniform coding symbols from the Manual for Erosion and Sediment Control in Georgia, Chapter 6, or equivalent.
6) Location of 100 year floodplain, if any, must be delineated on plan. Federal Emergency Management Agency (FEMA) procedures will be followed in arriving at floodplain determinations. Where encroachment into 100 year floodplain is proposed, provide documentation that project is in compliance with appropriate regulations.
7) 25 foot undisturbed buffers, and 100 foot management zones along designated trout streams must be delineated. Where encroachment into buffer is proposed, provide documentation that appropriate variances have been obtained.
8) Include soil series and their delineation.

Narrative, or notes, and other information: Notes or narrative should be located on the site plan under general notes or under erosion and sediment control notes.

Description of existing land use at project site and description of proposed project.
2) Name, address, and phone number of developer/owner.
3) Name and phone number of 24 hour local contact who is responsible for erosion and sediment controls.
4) Signature/Seal of qualified plan preparer.
5) Size of project, or phase under construction, in acres.
6) Activity schedule - show anticipated starting and completion dates for project. Include the statement in bold letters, that "The installation of erosion control measures and practices shall be installed prior to land-disturbing activities."
7) Include specific design information and calculations for all structural measures on site, such as temporary sediment basins, retrofit detention ponds, swales, etc.
8) Show storm drain pipe and weir velocities and demonstrate how receiving area will accommodate discharges without erosion.
9) Vegetative plan - for all temporary and permanent vegetative practices, including species, planting dates, and seeding, fertilizer, lime, and mulching rates. Vegetative plan should be site specific for appropriate time of year that seeding will take place.

10) Detailed drawings - for all structural practices. Specifications must, at a minimum, meet guidelines set forth in the Manual for Erosion and Sediment Control in Georgia.
11) Maintenance statement - "Erosion control measures will be maintained at all times. If full implementation of the approved plan does not provide for effective erosion control, additional erosion and sediment control measures shall be implemented to control or treat the sediment source."

Date _____, 19 ____

SOIL EROSION AND SEDIMENTATION CONTROL PERMIT

All Soil Erosion and Sediment Control measures shall conform to the Standards and Specifications of the Soil Erosion and Sediment Control Ordinance of Houston County.

Describe land activity to take place:

_____

_____

_____

_____ _____ _____

Name of Subdivision or Development | Location of Subdivision or Development

_____ _____ _____ _____

Open Acreage | Timber Acreage | Total Acreage | Total Number of Lots

_____ _____ _____

Owner of Subdivision or Development | Address | Phone

_____ _____ _____

Land Surveyor or Civil Engineer | Address | Phone

_____ _____ _____

Contractor | Address | Phone

Listed below are the inspections that are required by Houston County on all Subdivision/Development:

1. Completion of clearing and grubbing.
2. Completion of grading and drainage operation.
3. Completion of curb and gutter.
4. Completion of base.
5. Pavement.
6. Completion of final grading
7. Completion of grassing.
8. Sanitary Sewer Lines and Water Lines.
9. Final Inspection.
10. All ditches and drainage between lots where houses are to be built will be piped and covered, with necessary catch basins and drop inlets to carry all water.

The number to call when *Subdivision or Development* is ready for above listed inspections:

HOUSTON COUNTY PUBLIC WORKS
(Engineering and Water Dept.)
987-4280

I am the owner or his Representative of this Subdivision/Development and I understand that I am responsible for all Inspection Fees which pertains to the Soil Erosion and Sedimentation Control Plan for *this Subdivision/Development.* I also understand that Houston County will make the above listed inspections and I will be billed for Re-Inspections (Inspections of items that are not ready or properly installed when the initial inspection was made).

_____ _____

Date | Owner or Representative

_____ _____

Date | Witness

_____ _____

Date | Notary

CK NO. _____

CASH _____

Receipt No. _____

Appendix C — NOI Form Instructions

See Reverse for Instructions

Form Approved. OMB No. 2040-0086
Approval expires: 8-31-95

NPDES FORM

EPA

United States Environmental Protection Agency
Washington, DC 20460

Notice of Intent (NOI) for Storm Water Discharges Associated with Industrial Activity Under the NPDES General Permit

Submission of this Notice of Intent constitutes notice that the party identified in Section I of this form intends to be authorized by a NPDES permit issued for storm water discharges associated with industrial activity in the State identified in Section II of this form. Becoming a permittee obligates such discharger to comply with the terms and conditions of the permit. ALL NECESSARY INFORMATION MUST BE PROVIDED ON THIS FORM.

I. Facility Operator Information

Name: Phone:

Address: Status of Owner/Operator:

City: State: ZIP Code:

II. Facility/Site Location Information

Is the Facility Located on Indian Lands? (Y or N)

Name:

Address:

City: State: ZIP Code:

Latitude: Longitude: Quarter: Section: Township: Range:

III. Site Activity Information

MS4 Operator Name:

Receiving Water Body:

If You are Filing as a Co-permittee, Enter Storm Water General Permit Number:

Are There Existing Quantitative Data? (Y or N)

Is the Facility Required to Submit Monitoring Data? (1, 2, or 3)

SIC or Designated Activity Code: Primary: 2nd: 3rd: 4th:

If This Facility is a Member of a Group Application, Enter Group Application Number:

If You Have Other Existing NPDES Permits, Enter Permit Numbers:

IV. Additional Information Required for Construction Activities Only

Project Start Date:

Completion Date:

Estimated Area to be Disturbed (In Acres):

Is the Storm Water Pollution Prevention Plan in Compliance with State and/or Local Sediment and Erosion Plans? (Y or N)

V. Certification: I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Print Name:

Date:

Signature: _____

EPA Form 3510-6 (8-92)

Instructions - EPA Form 3510-6
Notice Of Intent (NOI) For Storm Water Discharges Associated With Industrial Activity
To Be Covered Under The NPDES General Permit

Who Must File A Notice Of Intent (NOI) Form

Federal law at 40 CFR Part 122 prohibits point source discharges of storm water associated with industrial activity to a water body(ies) of the U.S. without a National Pollutant Discharge Elimination System (NPDES) permit. The operator of an industrial activity that has such a storm water discharge must submit a NOI to obtain coverage under the NPDES Storm Water General Permit. If you have questions about whether you need a permit under the NPDES Storm Water program, or if you need information as to whether a particular program is administered by EPA or a state agency, contact the Storm Water Hotline at (703) 821-4823.

Where To File NOI Form

NOIs must be sent to the following address:

Storm Water Notice of Intent
PO Box 1215
Newington, VA 22122

Completing The Form

You must type or print, using upper-case letters, in the appropriate areas only. Please place each character between the marks. Abbreviate if necessary to stay within the number of characters allowed for each item. Use one space for breaks between words, but not for punctuation marks unless they are needed to clarify your response. If you have any questions on this form, call the Storm Water Hotline at (703) 821-4823.

Section I Facility Operator Information

Give the legal name of the person, firm, public organization, or any other entity that operates the facility or site described in this application. The name of the operator may or may not be the same as the name of the facility. The responsible party is the legal entity that controls the facility's operation, rather than the plant or site manager. Do not use a colloquial name. Enter the complete address and telephone number of the operator.

Enter the appropriate letter to indicate the legal status of the operator of the facility.

F = Federal M = Public (other than federal or state)
S = State P = Private

Section II Facility/Site Location Information

Enter the facility's or site's official or legal name and complete street address, including city, state, and ZIP code. If the facility or site lacks a street address, indicate the state, the latitude and longitude of the facility to the nearest 15 seconds, or the quarter, section, township, and range (to the nearest quarter section) of the approximate center of the site.

Indicate whether the facility is located on Indian lands.

Section III Site Activity Information

If the storm water discharges to a municipal separate storm sewer system (MS4), enter the name of the operator of the MS4 (e.g., municipality name, county name) and the receiving water of the discharge from the MS4. (A MS4 is defined as a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) that is owned or operated by a state, city, town, borough, county, parish, district, association, or other public body which is designed or used for collecting or conveying storm water.)

If the facility discharges storm water directly to receiving water(s), enter the name of the receiving water.

If you are filing as a co-permittee and a storm water general permit number has been issued, enter that number in the space provided.

Indicate whether or not the owner or operator of the facility has existing quantitative data that represent the characteristics and concentration of pollutants in storm water discharges.

Indicate whether the facility is required to submit monitoring data by entering one of the following:

1 = Not required to submit monitoring data;
2 = Required to submit monitoring data;
3 = Not required to submit monitoring data; submitting certification for monitoring exclusion

Those facilities that must submit monitoring data (e.g., choice 2) are: Section 313 EPCRA facilities; primary metal industries; land disposal units/incinerators/BIFs; wood treatment facilities; facilities with coal pile runoff; and, battery reclaimers.

List, in descending order of significance, up to four 4-digit standard industrial classification (SIC) codes that best describe the principal products or services provided at the facility or site identified in Section II of this application.

For industrial activities defined in 40 CFR 122.26(b)(14)(i)-(xi) that do not have SIC codes that accurately describe the principal products produced or services provided, the following 2-character codes are to be used:

HZ = Hazardous waste treatment, storage, or disposal facilities, including those that are operating under interim status or a permit under subtitle C of RCRA [40 CFR 122.26 (b)(14)(iv)];
LF = Landfills, land application sites, and open dumps that receive or have received any industrial wastes, including those that are subject to regulation under subtitle D of RCRA [40 CFR 122.26 (b)(14)(v)];
SE = Steam electric power generating facilities, including coal handling sites [40 CFR 122.26 (b)(14)(vii)];
TW = Treatment works treating domestic sewage or any other sewage sludge or wastewater treatment device or system, used in the storage, treatment, recycling, and reclamation of municipal or domestic sewage [40 CFR 122.26 (b)(14)(ix)]; or,
CO = Construction activities [40 CFR 122.26 (b)(14)(x)].

If the facility listed in Section II has participated in Part 1 of an approved storm water group application and a group number has been assigned, enter the group application number in the space provided.

If there are other NPDES permits presently issued for the facility or site listed in Section II, list the permit numbers. If an application for the facility has been submitted but no permit number has been assigned, enter the application number.

Section IV Additional Information Required for Construction Activities Only

Construction activities must complete Section IV in addition to Sections I through III. Only construction activities need to complete Section IV.

Enter the project start date and the estimated completion date for the entire development plan.

Provide an estimate of the total number of acres of the site on which soil will be disturbed (round to the nearest acre).

Indicate whether the storm water pollution prevention plan for the site is in compliance with approved state and/or local sediment and erosion plans, permits, or storm water management plans.

Section V Certification

Federal statutes provide for severe penalties for submitting false information on this application form. Federal regulations require this application to be signed as follows:

For a corporation: by a responsible corporate officer, which means: (i) president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision making functions, or (ii) the manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25 million (in second-quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

For a partnership or sole proprietorship: by a general partner or the proprietor; or

For a municipality, state, Federal, or other public facility: by either a principal executive officer or ranking elected official.

Paperwork Reduction Act Notice

Public reporting burden for this application is estimated to average 0.5 hours per application, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate, any other aspect of the collection of information, or suggestions for improving this form, including any suggestions which may increase or reduce this burden to: Chief, Information Policy Branch, PM-223, U.S. Environmental Protection Agency, 401 M Street, SW, Washington, DC 20460, or Director, Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503.

Appendix D — NOT Form Instructions

Please See Instructions Before Completing This Form

Form Approved. OMB No. 2040-0086
Approval expires: 8-31-95

NPDES FORM

EPA

United States Environmental Protection Agency
Washington, DC 20460

Notice of Termination (NOT) of Coverage Under the NPDES General Permit for Storm Water Discharges Associated with Industrial Activity

Submission of this Notice of Termination constitutes notice that the party identified in Section II of this form is no longer authorized to discharge storm water associated with industrial activity under the NPDES program. ALL NECESSARY INFORMATION MUST BE PROVIDED ON THIS FORM.

I. Permit Information

NPDES Storm Water General Permit Number: [ ]

Check Here if You are No Longer the Operator of the Facility: [ ]

Check Here if the Storm Water Discharge is Being Terminated: [ ]

II. Facility Operator Information

Name: [ ] Phone: [ ]

Address: [ ]

City: [ ] State: [ ] ZIP Code: [ ]

III. Facility/Site Location Information

Name: [ ]

Address: [ ]

C [ ] State: [ ] ZIP Code: [ ]

Latitude: [ ] Longitude: [ ] Quarter: [ ] Section: [ ] Township: [ ] Range: [ ]

IV. Certification: I certify under penalty of law that all storm water discharges associated with industrial activity from the identified facility that are authorized by a NPDES general permit have been eliminated or that I am no longer the operator of the facility or construction site. I understand that by submitting this Notice of Termination, I am no longer authorized to discharge storm water associated with industrial activity under this general permit, and that discharging pollutants in storm water associated with industrial activity to waters of the United States is unlawful under the Clean Water Act where the discharge is not authorized by a NPDES permit. I also understand that the submittal of this Notice of Termination does not release an operator from liability for any violations of this permit or the Clean Water Act.

Print Name: [ ] Date: [ ]

Signature: _____

Instructions for Completing Notice of Termination (NOT) Form

Who May File a Notice of Termination (NOT) Form

Permittees who are presently covered under the EPA issued National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Industrial Activity may submit a Notice of Termination (NOT) form when their facilities no longer have any storm water discharges associated with industrial activity as defined in the storm water regulations at 40 CFR 122.26 (b)(14), or when they are no longer the operator of the facilities.

For construction activities, elimination of all storm water discharges associated with industrial activity occurs when disturbed soils at the construction site have been finally stabilized and temporary erosion and sediment control measures have been removed or will be removed at an appropriate time, or that all storm water discharges associated with industrial activity from the construction site that are authorized by a NPDES general permit have otherwise been eliminated. Stabilization means that all soil-disturbing activities at the site have been completed, and that a uniform perennial vegetative cover with a density of 70% of the cover for unpaved areas and areas not covered by permanent structures has been established, or equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed.

Where to File NOT Form

Send this form to the the following address:

Storm Water Notice of Termination
P.O. Box 1185
Newington, VA 22122

Completing the Form

Type or print, using upper-case letters, in the appropriate areas only. Please place each character between the marks. Abbreviate if necessary to stay within the number of characters allowed for each item. Use only one space for breaks between words, but not for punctuation marks unless they are needed to clarify your response. If you have any questions about this form, call the Storm Water Hotline at (703) 821-4823.

PLEASE SEE REVERSE OF THIS FORM FOR FURTHER INSTRUCTIONS

EPA Form 3510-7 (8-92)

APPENDIX D
SOIL CONSERVATION SERVICE
CHART METHOD FOR PEAK DISCHARGES

PEAK DISCHARGES

SCS CHART METHOD

INTRODUCTION

A quick and reliable method of computing peak discharges from drainage areas 1 to 2,000 acres in size is given in Figures A-2.3 to A-2.5. The charts were prepared for the solution of the general relationships and are based on type-II rainfall distribution.

Type-II storms occur in regions where the high rates of runoff from small areas are usually generated from summer thunderstorms.

This chapter presents a method of adjusting peak discharges obtained from the charts to reflect the increase in peak discharge due to urbanization. Additional methods for interpolating or adjusting peak discharges for conditions not found on the charts or not represented by the general equations in this chapter are given later in this chapter.

MODIFICATION OF PEAK DISCHARGE DUE TO URBANIZATION

Research in the area of urban hydrology is developing rapidly. Research to date has been sufficient to identify the parameters that are affected by urbanization and to derive limited empirical relationships between those parameters for both agricultural and urban watersheds. The time to peak for urban watersheds is affected by a decrease in lag or time of concentration as described in TR-55 (Appendix A-1).

Figures A-2.1 and A-2.2 give factors for adjusting peaks calculated from Figures A-2.3 to A-2.5 based on the same parameters that affect watershed lag and time of concentration. The factors are applied to the peaks using future-condition runoff curve numbers as follows:

$$Q_{MOD} = Q\,[\text{Factor}_{IMP}]\,[\text{Factor}_{HLM}] \qquad \text{(Eq. A-2.1)}$$

where

Q_{MOD} = modified discharge due to urbanization

Q = discharge for future CN using charts (Figures A-2.3, A-2.4 or A-2.5)

Factor_{IMP} = adjustment factor for percent impervious areas

Factor_{HLM} = adjustment factor for percent of hydraulic length modified.

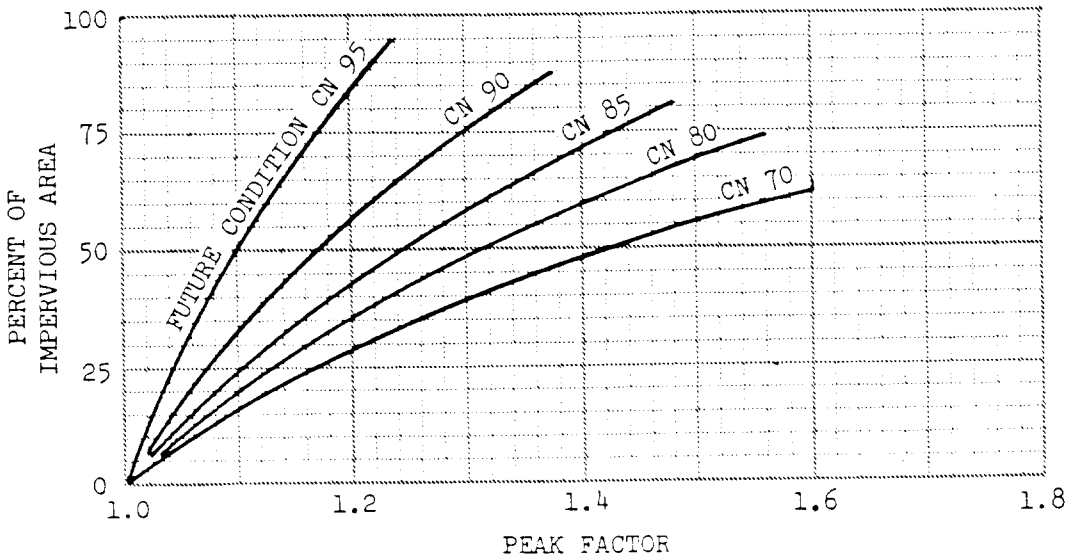


Figure A-2.1 - Factors for adjusting peak discharges for a given future-condition runoff curve number based on the percentage of impervious area in the watershed.

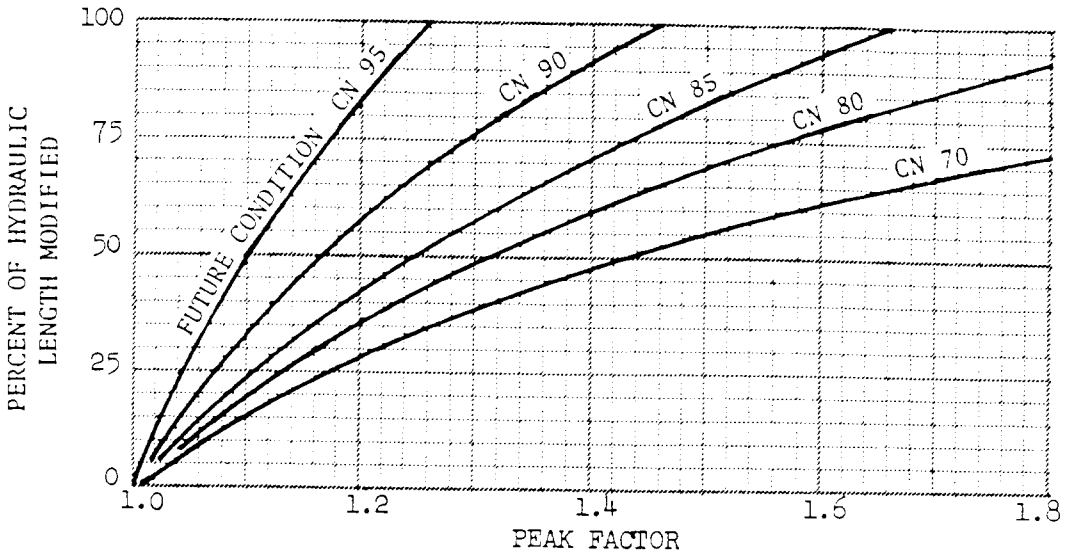


Figure A-2.2 - Factors for adjusting peak discharges for a given future-condition runoff curve number based on the percentage of hydraulic length modified.

Example A-2.1

A 300-acre watershed is to be developed. The runoff curve number for the proposed development is computed to be 80. Approximately 60 percent of the hydraulic length will be modified by the installation of street gutters and storm drains to the watershed outlet. Approximately 30 percent of the watershed will be impervious. The average watershed slope is estimated to be 4 percent. Compute the present-condition and anticipated future-condition peak discharge for a 50-year/24-hour storm event with 5 inches of rainfall. The present-condition runoff curve number is 75.

1. From TR-55, Table 2-1 (Appendix A-1), the runoff for present condition is 2.45 inches and for future conditions is 2.89 inches.
2. From the chart for moderate slope in Figure A-2.4 (CN=75), the present condition peak discharge is 120 cfs (cubic feet per second) per inch of runoff. The peak discharge is then 120 x 2.45 or 294 cfs.
3. From the chart for moderate slope in Figure A-2.4 (CN=80), the future-condition base discharge for (CN=80) is 133 cfs per inch of runoff. The base discharge is then 133 x 2.89 or 384 cfs.
4. From Figure A-2.1 with 30 percent impervious area and future runoff curve number of 80, read peak factor = 1.16.
5. From Figure A-2.2, with 60 percent of the hydraulic length modified and future-condition curve number of 80, read peak factor = 1.42.
6. The future-condition peak discharge is:

   384 (1.16)(1.42) = 633 cfs

7. The effect of this proposed development is to increase the peak discharge from 294 to 633 cfs.

ADJUSTMENT FACTORS FOR PEAKS DETERMINED USING FIGURES A-2.3 THOUGH A-2.5

This section describes methods for adjusting peak rates of discharge for ranges of flat, moderate, and steep slopes; for conditions where swamps or ponding areas exist; and for conditions where the watershed shape factor (l/w) varies significantly from that used in the development of the charts of Figures A-2.3 through A-2.5.

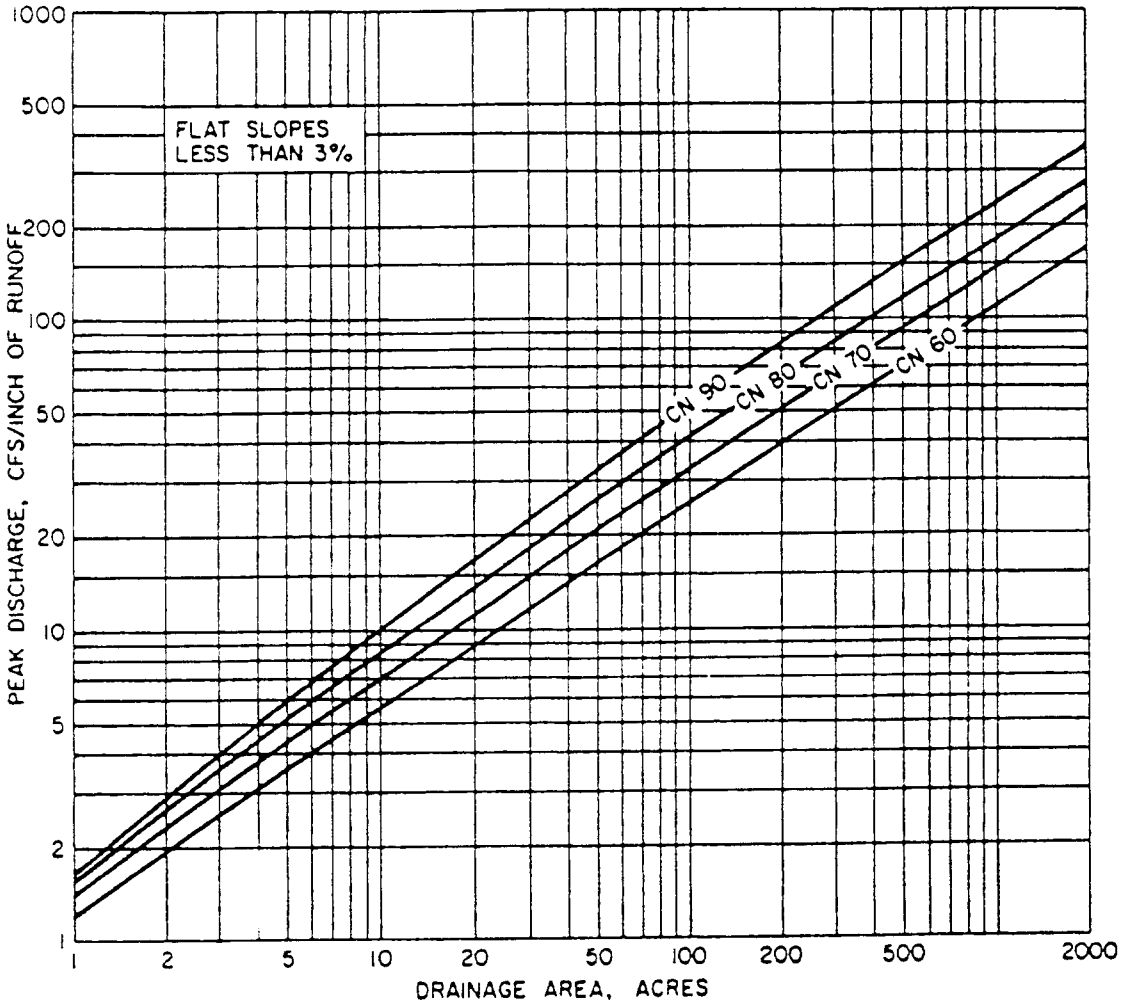
SLOPE INTERPOLATION

Table A-2.1 provides interpolation factors to be used in determining peak rates of discharge for specific slopes within ranges of flat, moderate, and steep slopes for a range of drainage areas. Figure A-2.3, for FLAT slopes is based on 1-percent slope, Figure A-2.4, for MODERATE slopes on 4-percent slope, and Figure A-2.5 for STEEP slopes on 16-percent slope. For slopes other than 1, 4, and 16 percent, use the factors shown in Table A-2.1 to modify the peak discharges.

Example A-2.2

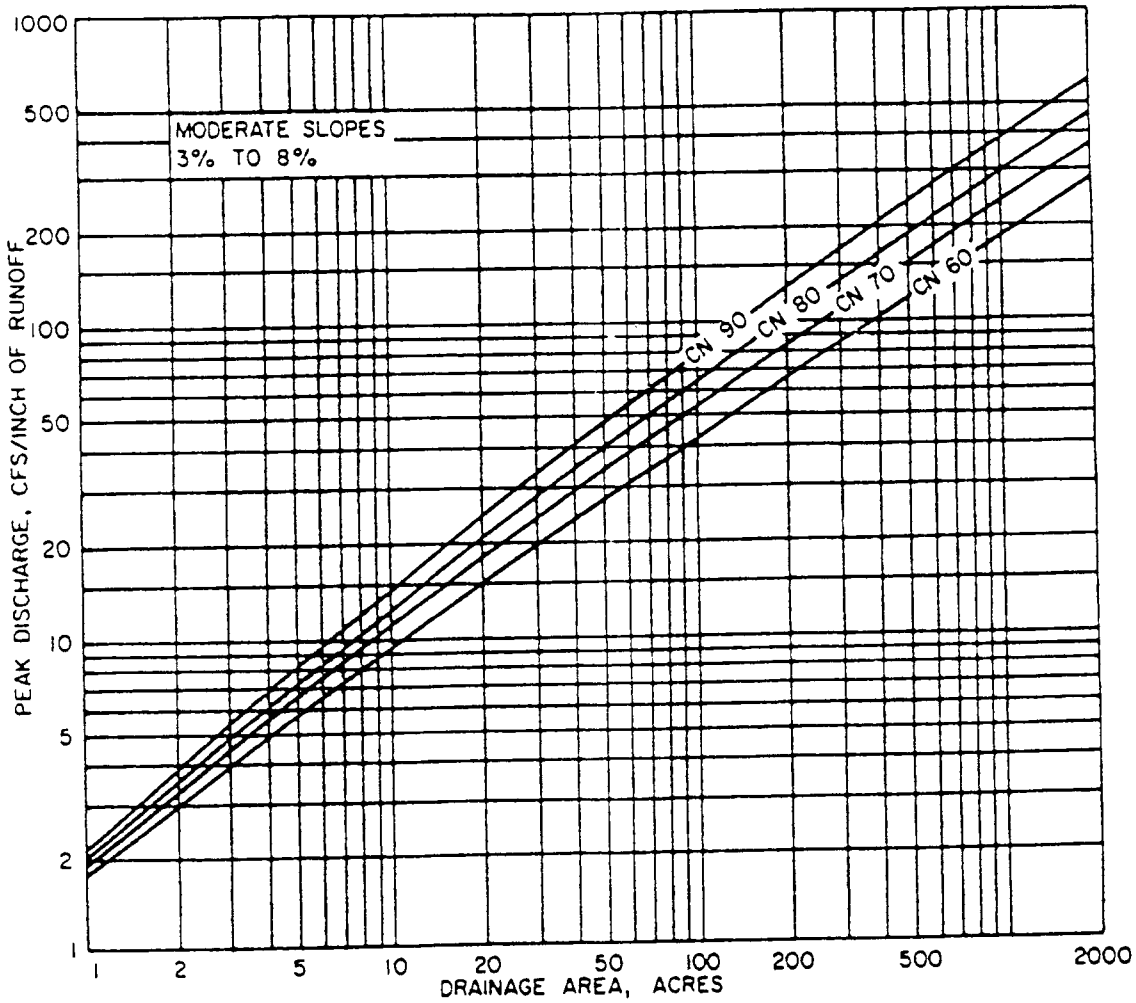
Compute the peak discharge for a 1,000-acre watershed with an average watershed slope of 7 percent and a runoff curve number (CN) of 80 for central Lee County, 2-year/24-hour storm.

1. Determine the peak discharge for a watershed with a moderate slope (4 percent). From Figure A-2.4, read a peak discharge of 295 cfs per inch of runoff for 1,000 acres and a CN of 80. From Figure A-2.8, Lee County as a P value of 4.0 inches. From TR-55,



PEAK RATES OF DISCHARGE FOR SMALL WATERSHEDS (24 HOUR, TYPE II STORM DISTRIBUTION)

Figure A-2.3



PEAK RATES OF DISCHARGE FOR SMALL WATERSHEDS (24-HOUR, TYPE II STORM DISTRIBUTION)

Figure A-2.4

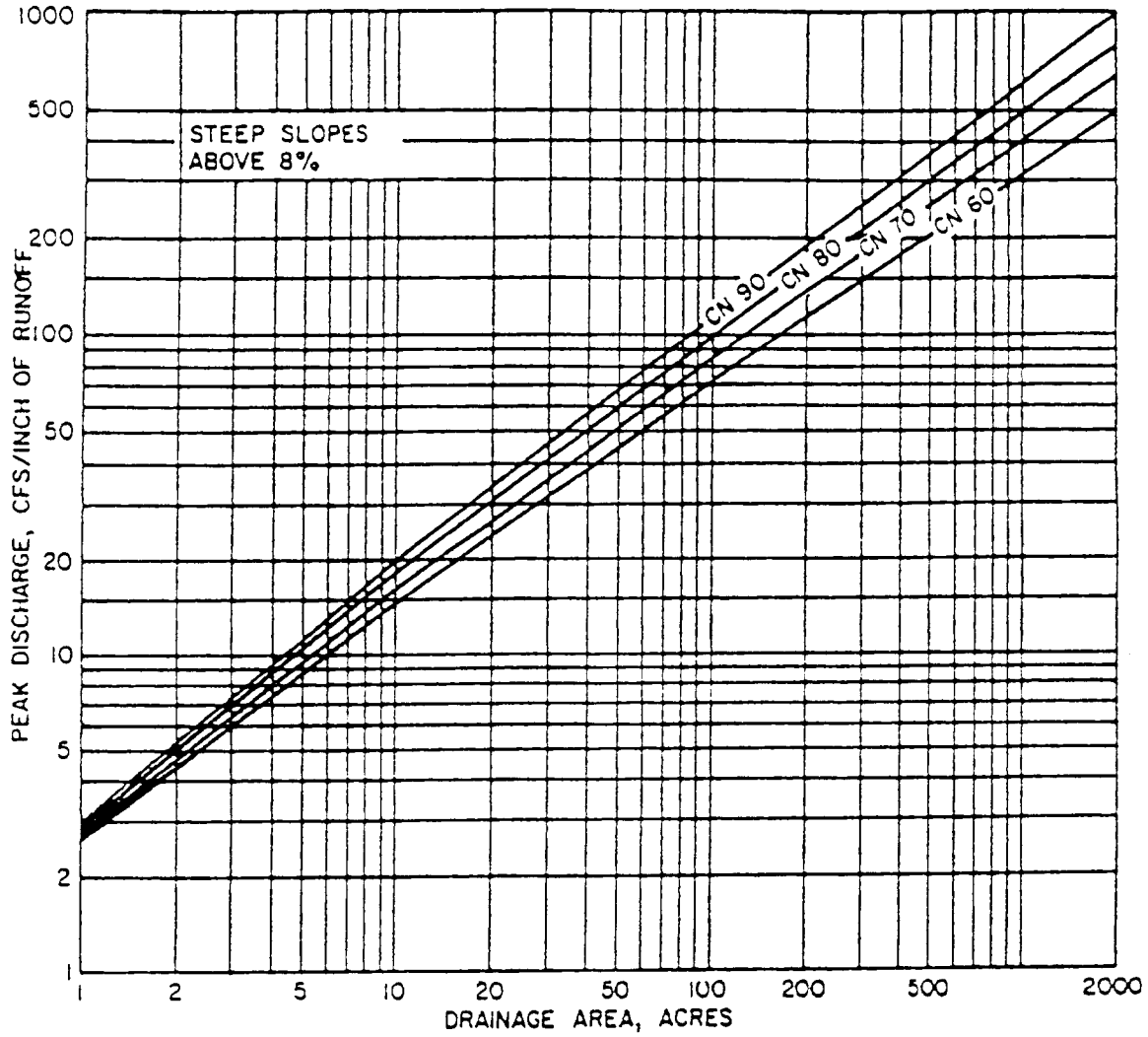


Figure A-2.5. - Peak rates of discharge for small watersheds (24-hour, type II storm distribution).

Table 2-1 (Appendix A-1) find 2.04 inches of runoff from 4 inches of rainfall and a CN of 80. The peak discharge is then 295 x 2.04 or 602 cfs.

2. Determine the interpolation factor. From Table A-2.1, find 7-percent slope under MODERATE heading and read an interpolation factor of 1.23 for a drainage area of 1,000 acres. (The peak from a 1,000-acre watershed with a watershed slope of 7 percent is 1.23 times greater than for an average watershed slope of 4 percent.)
3. Determine the peak discharge of 7-percent slope.

q = (602)(1.23) = 740 cfs

Examples A-2.3

Compute the peak discharge for a 15-acre watershed with an average slope of 0.5 percent and a runoff curve number of 80 for 4 inches of rainfall.

1. Determine the peak discharge for a watershed with a flat slope (1 percent). From Figure A-2.3 read a peak discharge of 11.2 cfs per inch of runoff for 15 acres and a CN of 80. From Table A-2.1, find 2.04 inches of runoff for 4 inches of rainfall and a CN of 80. The peak discharge is then 11.2 x 2.04 or 23 cfs.
2. Determine the interpolation factor. From Table A-2.1 find 0.5-percent slope under FLAT heading. Read a slope interpolation factor of 0.81 interpolated between the values for 10 acres and 20 acres.
3. Determine the peak discharge for 0.5-percent slope.

q = (23)(.81) = 19 cfs

Table A-2.1. - Slope adjustment factors by drainage areas.

Slope (percent)	10 acres	20 acres	50 acres	100 acres	200 acres	500 acres	1,000 acres	2,000 acres
FLAT SLOPES								
0.1	0.49	0.47	0.44	0.43	0.42	0.41	0.41	0.40
0.2	.61	.59	.56	.55	.54	.53	.53	.52
0.3	.69	.67	.65	.64	.63	.62	.62	.61
0.4	.76	.74	.72	.71	.70	.69	.69	.69
0.5	.82	.80	.78	.77	.77	.76	.76	.76
0.7	.90	.89	.88	.87	.87	.87	.87	.87
1.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.5	1.13	1.14	1.14	1.15	1.16	1.17	1.17	1.17
2.0	1.21	1.24	1.26	1.28	1.29	1.30	1.31	1.31
MODERATE SLOPES								
3	.93	.92	.91	.90	.90	.90	.89	.89
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	1.04	1.05	1.07	1.08	1.08	1.08	1.09	1.09
6	1.07	1.10	1.12	1.14	1.15	1.16	1.17	1.17
7	1.09	1.13	1.18	1.21	1.22	1.23	1.23	1.24
STEEP SLOPES								
8	.92	.88	.84	.81	.80	.78	.78	.77
9	.94	.90	.86	.84	.83	.82	.81	.81
10	.96	.92	.88	.87	.86	.85	.84	.84
11	.96	.94	.91	.90	.89	.88	.87	.87
12	.97	.95	.93	.92	.91	.90	.90	.90
13	.97	.97	.95	.94	.94	.93	.93	92
14	.98	.98	.97	.96	.96	.96	.95	.95
15	.99	.99	.99	.98	.98	.98	.98	.98
16	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10
25	1.06	1.08	1.12	1.14	1.15	1.16	1.17	1.19
30	1.09	1.11	1.14	1.17	1.20	1.22	1.23	1.24
40	1.12	1.16	1.20	1.24	1.29	1.31	1.33	1.35
50	1.17	1.21	1.25	1.29	1.34	1.37	1.40	1.43

ADJUSTMENT FACTORS FOR SWAMPY AND PONDING AREAS

Peak flows determined from Figure A-2.3 through A-2.5 assume that the topography is such that surface flow into ditches, drains, and streams is approximately uniform. On very flat areas and where ponding or wampy areas occur in the watershed, a considerable amount of the surface runoff may be retained in temporary storage. The peak rate of runoff should be reduced to reflect this condition. Tables A-2.2, A-2.3, and A-2.4 provide adjustment factors to determine this reduction based on the ratio of the ponding or swampy area to the total watershed area for a range of storm frequencies.

Table A-2.2 contains adjustment factors to be used when the ponding or swampy areas are located in the path of flow in the vicinity of the design point. Table A-2.3 contains adjustment factors to be used when a significant amount of the flow from the total watershed passes through ponding or swampy areas and these areas are spread throughout the watershed. Table A-2.4 contains adjustment factors to be used when a significant amount of the flow passes through ponding or swampy areas that are located in the upper reaches of the watershed.

These conditions may occur in a proposed or existing urban or suburban area and the adjustment factors from Tables A-2.2, A-2.3, or A-2.4 should be applied after the peaks have been adjusted for the effects of urbanization.

Table A-2.2 - Peak flow adjustment factors where ponding and swampy areas occur at the design point

Ratio of drainage area to ponding and swampy area	Percentage of ponding and swampy area	Storm frequency (years)						
		1	2	5	10	25	50	100
500	0.2	0.91	0.92	0.94	0.95	0.96	0.97	0.98
200	.5	.85	.86	.87	.88	.90	.92	.93
100	1.0	.79	.80	.81	.83	.85	.87	.89
50	2.0	.73	.74	.75	.76	.79	.82	.86
40	2.5	.68	.69	.70	.72	.75	.78	.82
30	3.3	.63	.64	.65	.67	.71	.75	.78
20	5.0	.58	.59	.61	.63	.67	.71	.75
15	6.7	.56	.57	.58	.60	.64	.67	.71
10	10.0	.52	.53	.54	.56	.60	.63	.68
5	20.0	.47	.48	.49	.51	.55	.59	.64

Table A-2.3 - Peak flow adjustment factors where ponding and swampy areas are spread throughout the watershed or occur in central parts of the watershed.

Ratio of drainage area to ponding and swampy area	Percentage of ponding and swampy area	Storm frequency (years)						
		1	2	5	10	25	50	100
500	0.2	0.93	0.94	0.95	0.96	0.97	0.98	0.99
200	.5	.87	.88	.89	.90	.91	.92	.94
100	1.0	.83	.83	.84	.86	.87	.88	.90
50	2.0	.77	.78	.79	.81	.83	.85	.87
40	2.5	.72	.73	.74	.76	.78	.81	.84
30	3.3	.68	.69	.70	.71	.74	.77	.81
20	5.0	.64	.65	.66	.68	.72	.75	.78
15	6.7	.61	.62	.63	.65	.69	.72	.75
10	10.0	.57	.58	.59	.61	.65	.68	.71
5	20.0	.52	.53	.54	.56	.60	.63	.68
4	25.0	.49	.50	.51	.53	.57	.61	.66

Table A-2.4 - Peak flow adjustment factors where ponding and swampy areas are located only in upper reaches of the watershed.

Ratio of drainage area to ponding and swampy area	Percentage of ponding and swampy area	Storm frequency (years)						
		1	2	5	10	25	50	100
500	0.2	0.95	0.96	0.97	0.98	0.98	0.99	0.99
200	.5	.92	.93	.94	.94	.95	.96	.97
100	1.0	.89	.90	.91	.92	.93	.94	.95
50	2.0	.86	.87	.88	.88	.90	.91	.93
40	2.5	.84	.85	.85	.86	.88	.89	.91
30	3.3	.81	.82	.83	.84	.86	.88	.89
20	5.0	.79	.80	.81	.82	.84	.86	.88
15	6.7	.77	.78	.79	.80	.82	.84	.86
10	10.0	.76	.77	.77	.78	.80	.82	.84
5	20.0	.73	.74	.75	.76	.78	.80	.82

Example A-2.4

A 5-acre pond is located at the downstream end of 100-acre watershed in which a housing development is proposed. The average watershed slope is 4 percent and the present-condition curve number is 75. After the installation of the housing development, 30 percent of the watershed will be impervious and 50 percent of the hydraulic length will be modified. The future-condition curve number is estimated to be 80. For a 100-year storm 24-hour duration in central Glascock County, determine the present-condition and future-condition peak discharges downstream of the pond.

1. Determine the present-condition peak discharge assuming the pond is not in place. From Figure A-2.4, find the peak discharge to be 59 cfs per inch of runoff. From Figure A-2.13, the rainfall for central Glascock County is 8 inches. From TR-55, Table 2-1 (Appendix A-1) find the runoff to be 5.04 inches. The peak discharge is 59 x 5.04 or 297 cfs.
2. Determine the ponding adjustment factor. Since the pond is at the lower end of the watershed, use Table A-2.2. The ratio of the drainage area to pond area is 100/5 or 20. For a 100-year frequency event, the adjustment factor is 0.75.
3. Compute the present-condition peak discharge.

   q = 0.75 (297) = 223 cfs

4. Compute the basic future-condition peak discharge. From Figure A-2.4, find the peak discharge to be 65 cfs per inch of runoff. From TR-55, Table 2-1, (Appendix A-1), find the runoff to be 5.62 inches. The peak discharge is then 65 x 5.62 or 365 cfs.
5. Determine the modification factors for proposed urbanization. Taken from Figures A-2.1 and A-2.2 for a curve number of 80: impervious factor = 1.16; hydraulic length factor = 1.31; urbanization factor = (1.16) (1.31) = 1.52.
6. Compute the future condition peak discharge.

   q = 1.52 (365) = 555 cfs

7. Compute the future-condition peak below the pond. From step 2 the ponding factor is 0.75.

   q = 0.75 (555) = 416 cfs

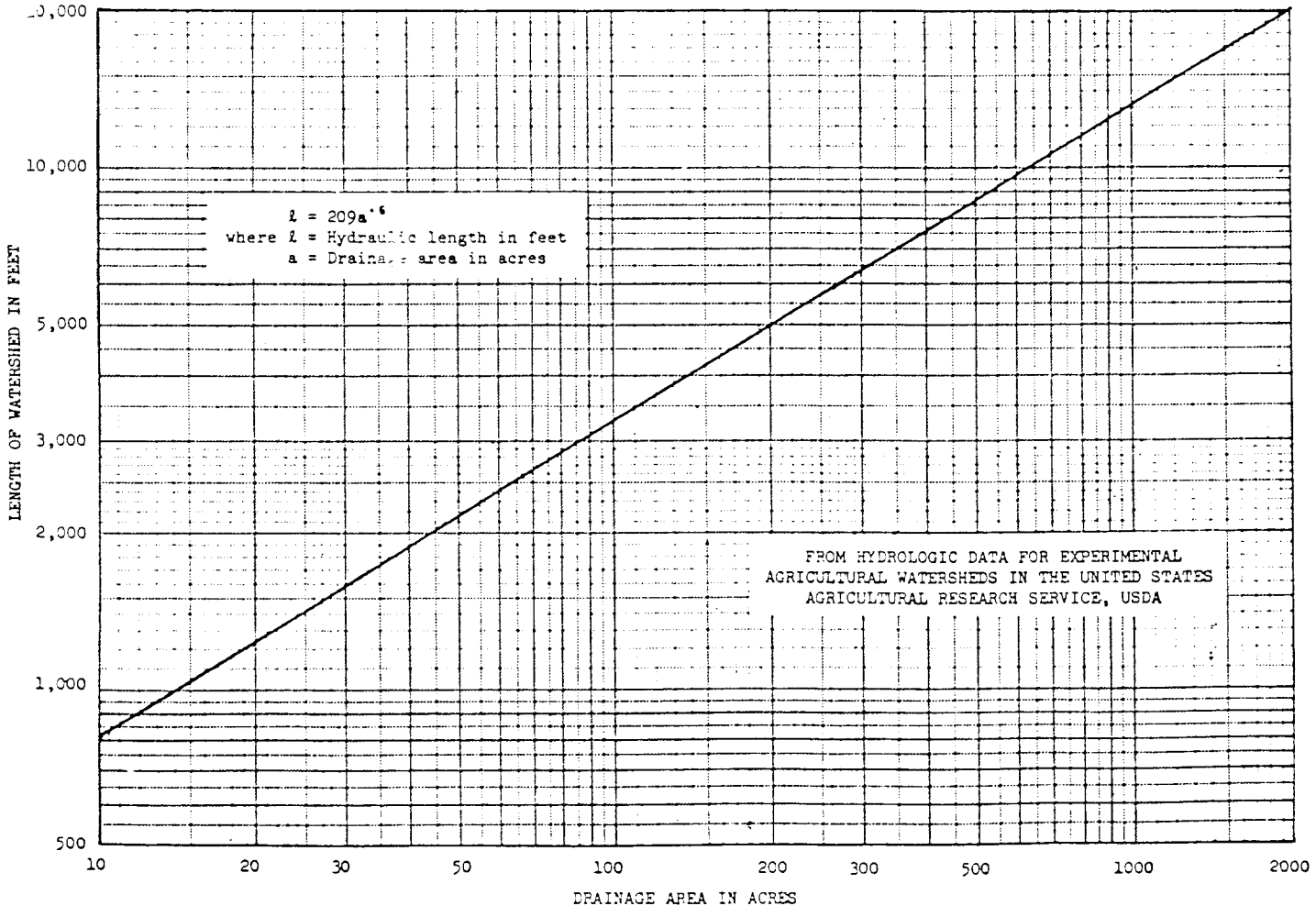


Figure A-2.6 - Hydraulic length and drainage area relationship.

ADJUSTMENT FOR WATERSHED SHAPE FACTOR

The equation used in computing peak discharges from Figures A-2.3 through A-2.5 was based in part on a relationship between the hydraulic length and the watershed area from Agricultural Research Services's studies on small experimental watersheds. Figure A-2.6 shows the best fit line relating length to drainage area. The equation of the line is $l = 209a^{0.6}$. A watershed shape factor, l/w (where w is the average width of the watershed), is then fixed for any given drainage area. For example, for drainage areas of 10, 100, and 1,000 acres, the watershed shape factor is 1.58, 2.51, and 3.98, respectively.

There are watersheds that deviate considerably from these relationships. The peaks can be modified for other shape factors. The procedure is as follows:

1. Determine the hydraulic length of the watershed and compute "equivalent" drainage area using $l = 209a^{0.6}$ or Figure A-2.6.
2. Determine the "equivalent" peak flow from the charts for the "equivalent" drainage area.
3. Compute the "actual" peak discharge for the watershed by multiplying the equivalent peak discharge by the ratio of actual drainage area to the equivalent drainage area.
   The factors for modifying the peak for urbanization can then be applied to the revised peak discharge.

Example A-2.5

From a topographic map the hydraulic length of a 100-acre watershed with moderate slopes and a CN of 75 was measured to be 2,200 feet. Determine the peak discharge for a 6-inch, 24-hour rainfall.

1. Determine the "equivalent" drainage area for a watershed with a hydraulic length of 2,200 feet. From Figure A-2.6, read 51 acres. (Note that in a 100-acre watershed, the hydraulic length would be 3,300 feet from Figure A-2.6).
2. Determine the "equivalent" peak flow from figure A-3.4 for a drainage area of 51 acres and a CN of 75. Read 37 cfs per inch of runoff. From TR-55 Table 2-1 (Appendix A-1), find the runoff to be 3.28 or 121 cfs.
3. Compute the actual peak discharge for 100 acres.

$$\text{actual discharge} = \text{equivalent discharge} \left(\frac{\text{actual drainage area}}{\text{equivalent drainage area}} \right)$$

$$q = 121 \left(\frac{100}{51} \right) = 237 \text{ cfs}$$

The peak discharge for the 100-acre watershed with a hydraulic length of 2,200 feet is 237 cfs (versus 194 cfs for a "normal" 100-acre watershed). Adjustments to this peak discharge for urbanization can be made using factors discussed on page A-2.1.

4. The procedure in steps 1, 2, and 3 can be used to determine peak discharges when the actual hydraulic length is longer than that shown on Figure A-2.6. For example, if the actual length were 4,500 feet instead of 3,300 feet, the equivalent area would be 170 acres, as shown in Figure A-2.6.

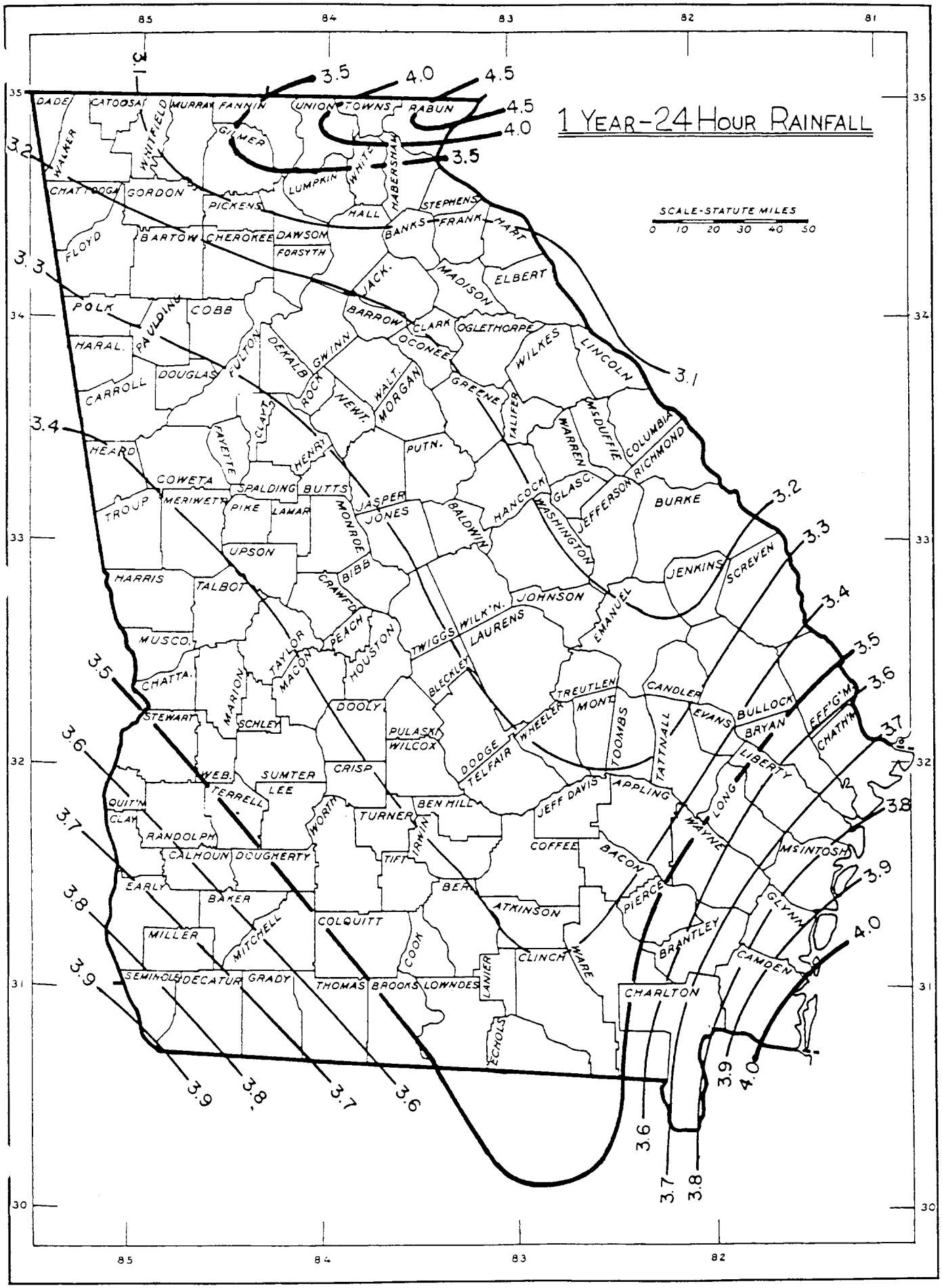


Figure A-2.7 - Total rainfall (P) for 1-year/24-hour storm.

GEORGIA

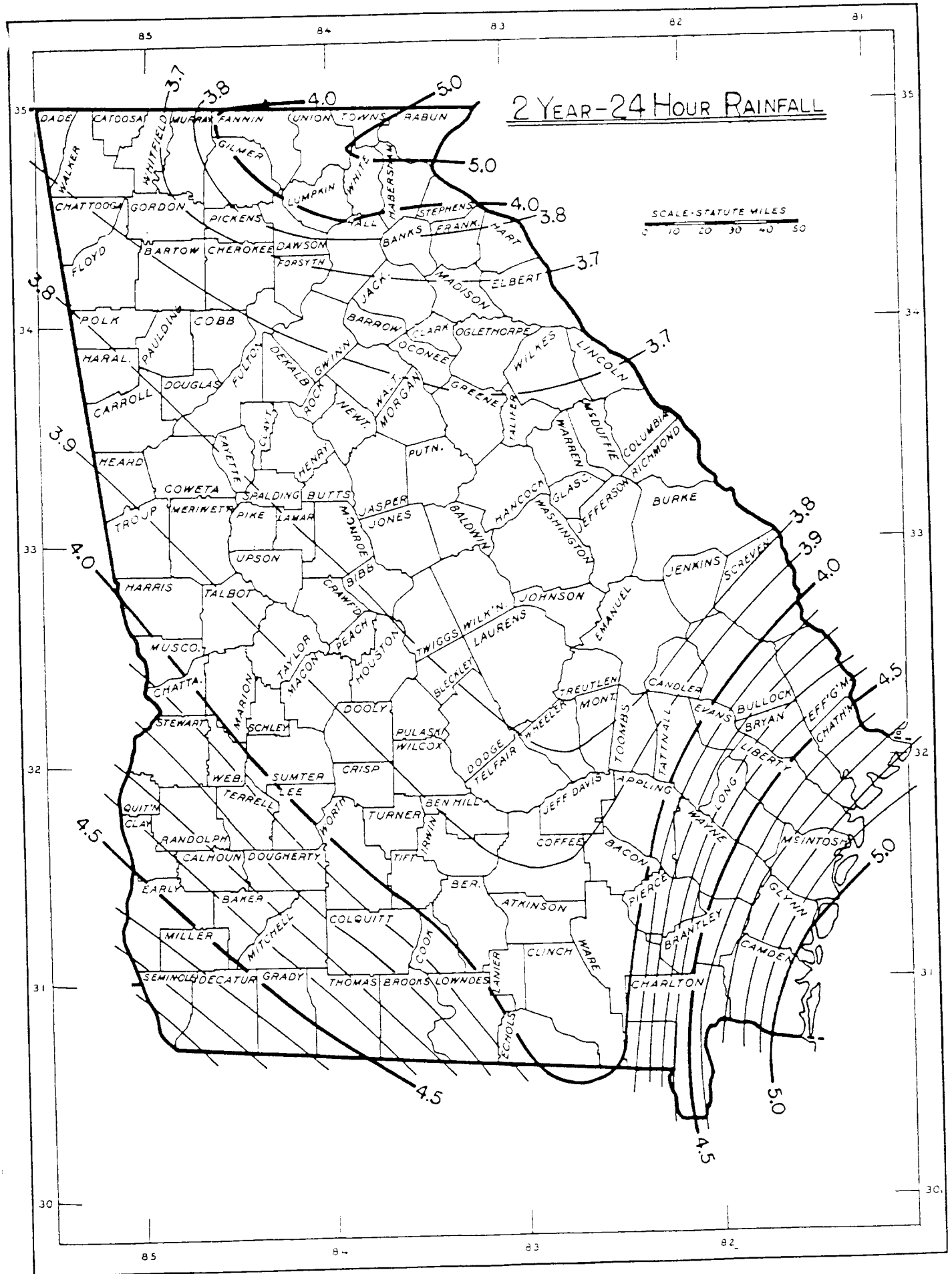


Figure A-2.8 - Total rainfall (P) for 2-year/24-hour storm.

GEORGIA

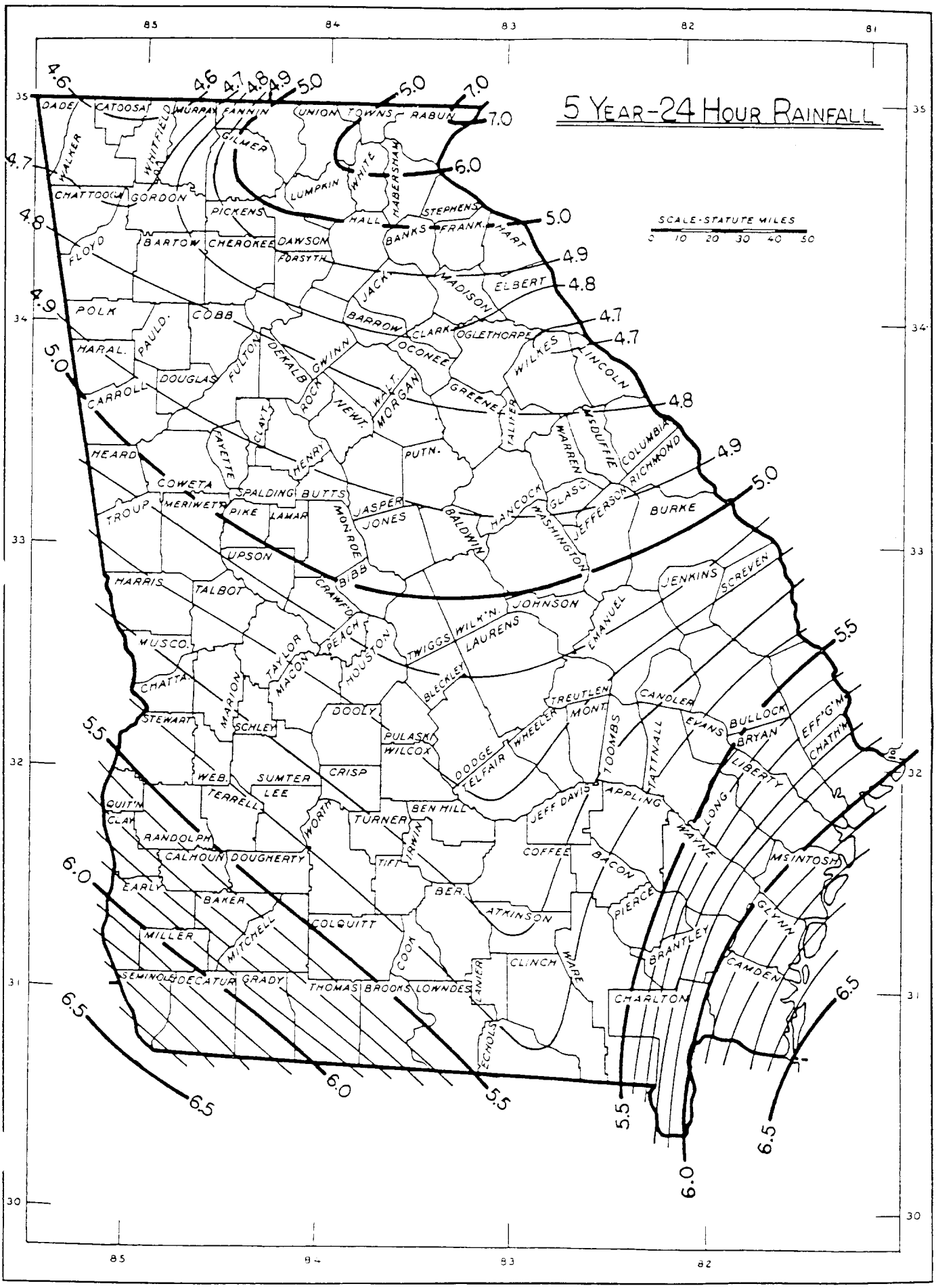


Figure A-2.9 - Total rainfall (P) for 5-year/24-hour storm.

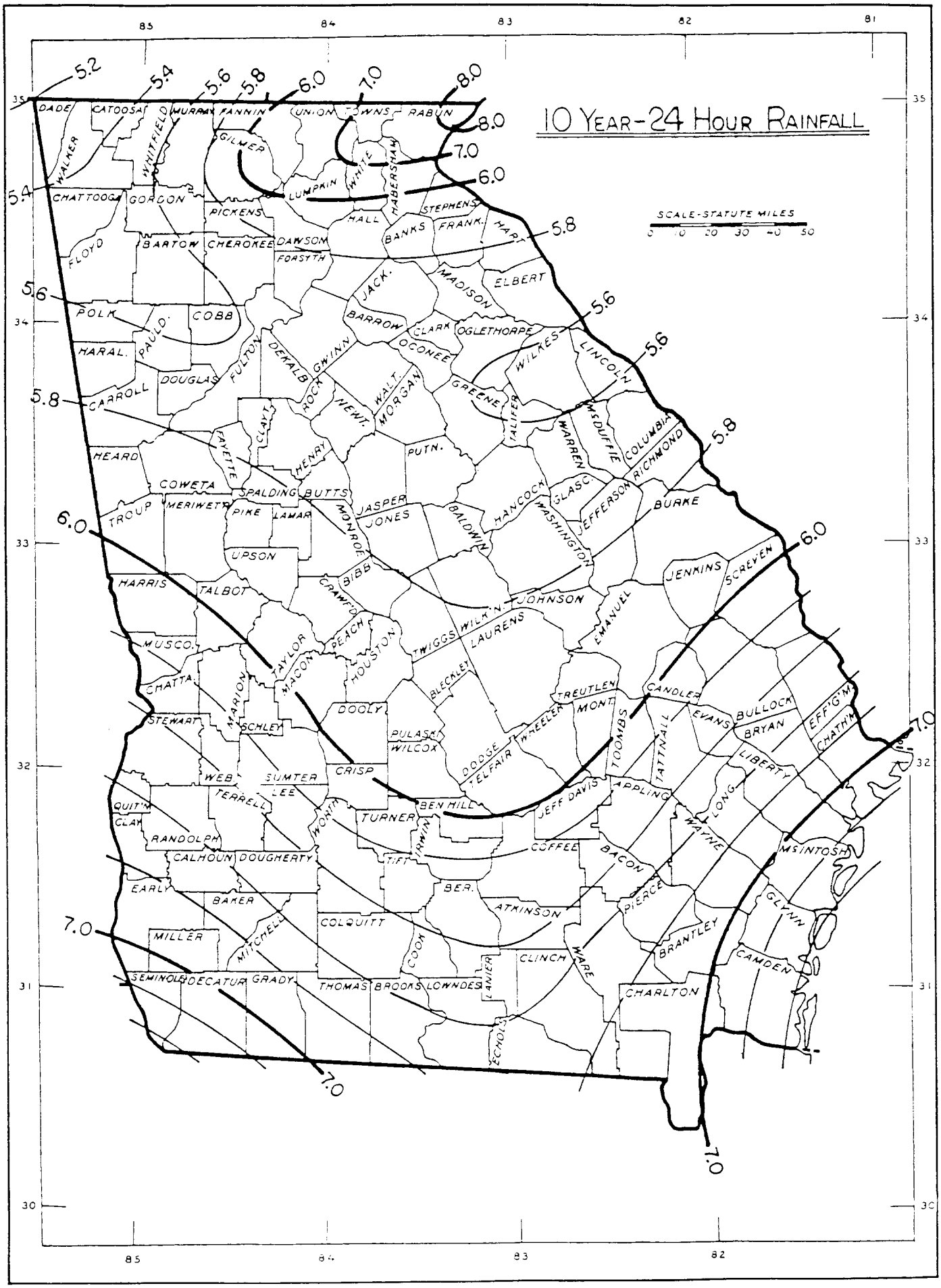


Figure A-2.10 - Total rainfall (P) for 10-year/24-hour storm.

GEORGIA

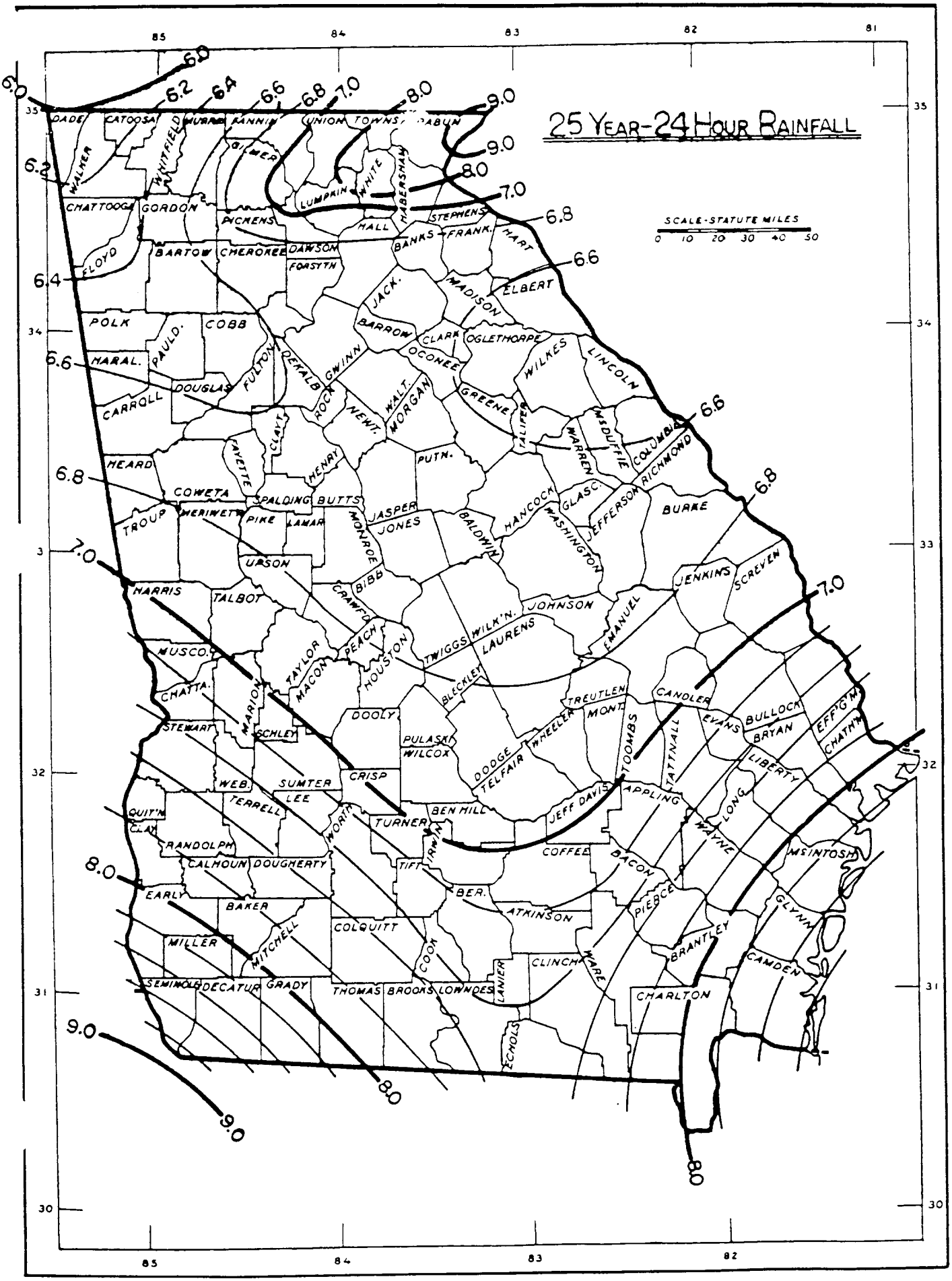


Figure A-2.11 Total rainfall (P) for 25 year/24 hour storm

GEORGIA

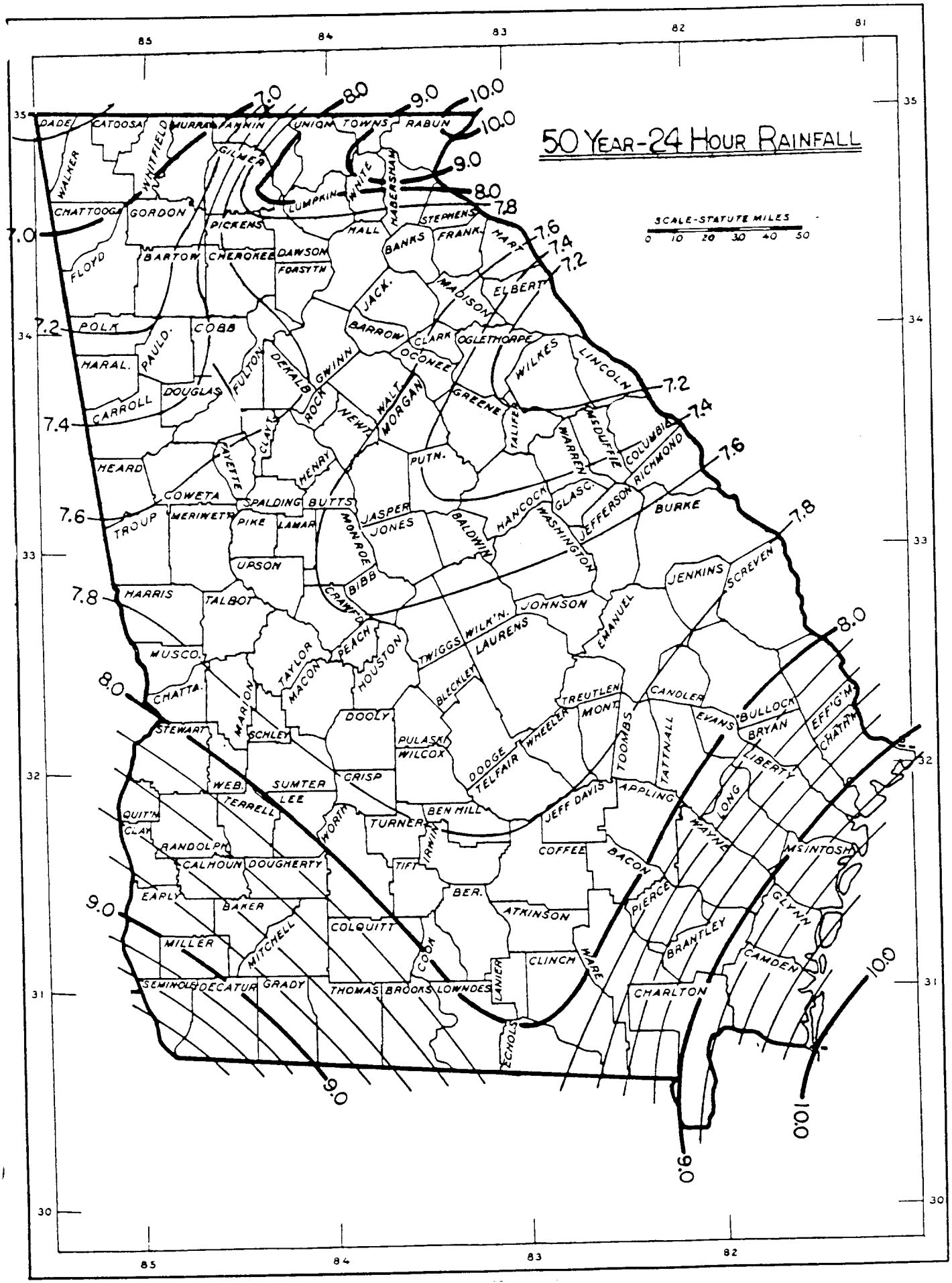


Figure A-2.12 - Total rainfall (P) for 50-year/24-hour storm.

GEORGIA

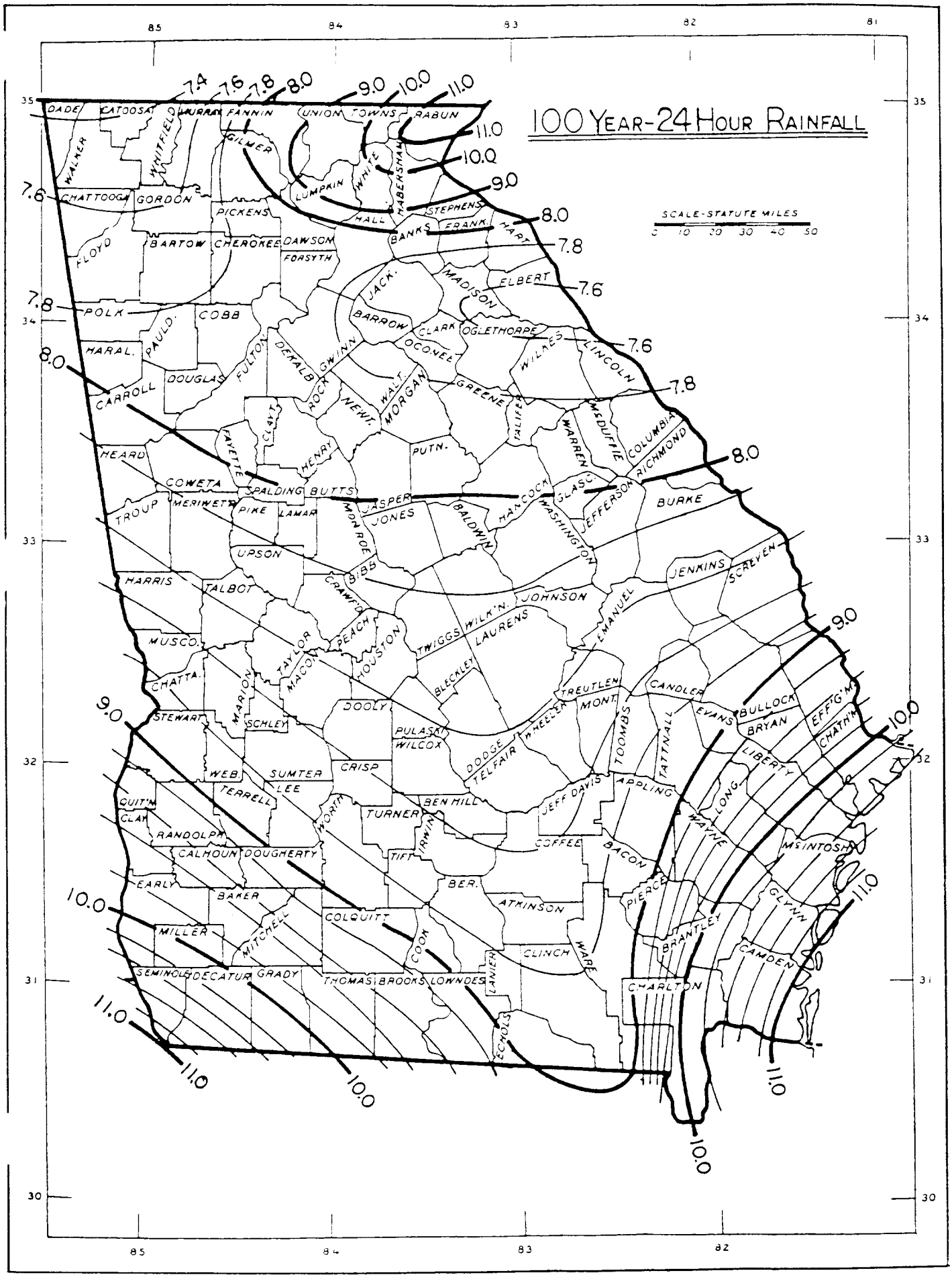


Figure A-2.13 - Total rainfall (P) for 100-year/24-hour storm.